Analyzing Crash and Severity Patterns in Greensboro, North Carolina. (2021)

Christian, Walters A., MA.

Project Submitted : April 16, 2021

Directed by Dr. John Stehlin.

ACKNOWLEDGEMENTS

There were many people who contributed to the completion of this internship project. First and foremost, I would like to give a huge thank you to my wonderful and very patient advisor Dr. John Stehlin who was with me every step of the way during the thesis track and then the internship track. This project would not have been done if not for Dr. Stehlin.

I would also like to thank Lydia McIntyre for giving me the opportunity to work for the City of Greensboro and teaching me many valuable lessons throughout my employment at the GDOT Metropolitan Planning Organization.

I also want to thank the GDOT/MPO at large for all the help and guidance that they have given me throughout this project. They include Tram Truong, Yuan Zhou, and Craig McKinney.

My final thanks go out to the wonderful UNCG Department of Geography, Environment, and Sustainability for teaching me all I know about Geography and Urban Planning, and for also inspiring me to pursue my academic goals.

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CHAPTER I: INTRODUCTION

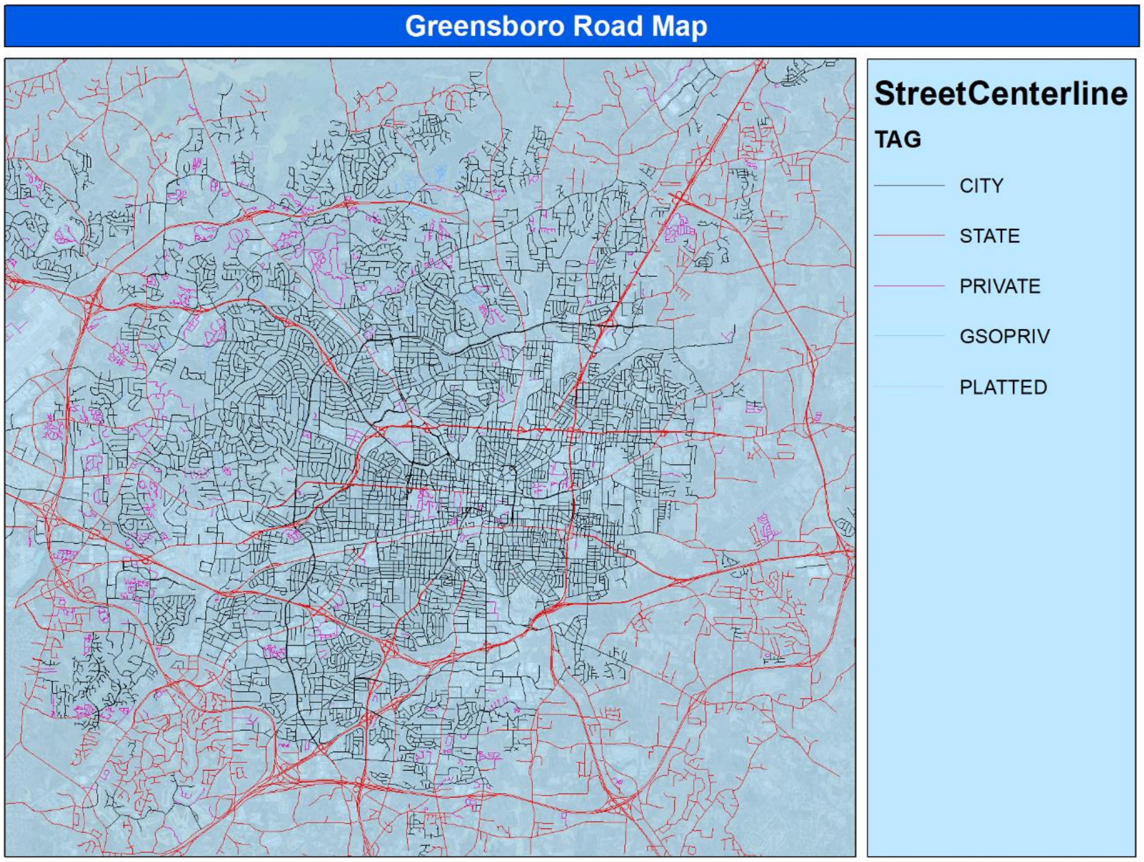
Understanding vehicular crashes is an important aspect of transport planning. Transportation planners have a moral responsibility to care for the general well-being as well as to lower costs associated with injuries, infrastructure repairs, and damages to vehicles, which can be a major economic setback for counties and states. According to the CDC, deaths occurring from traffic crashes resulted in $55 billion in medical and work lost costs in 2018 (CDC, 2018). Agencies like the Greensboro Department of Transportation are concerned with the high prevalence of crashes and their costs. They collect demographic, roadway, and built environment data to understand patterns of crashes, especially ones that result in severe injuries or death, and contributing factors like speed limit or roadway configuration. Because of the higher risk to human bodies that come with walking or biking, there are serious consequences to crashes involving an automobile and a bicyclist or pedestrian. A shift in the way that crashes are identified by planners is happening because, previously, the term that was used to describe traffic violence was "accidents" but planners don't think that they are accidents but more of a result of the built environment so now they use the term "crash" (Shahum, 2019).

Urban planning policies in the United States have been mostly auto-centric since the rise of suburbanization, white flight, and the construction of the Interstate Highway System. With ownership of automobiles beginning to rise after World War 2 due to lower costs, the middle to upper income families moved out of cities and brought their tax dollars to suburban communities. Suburbanization, as defined by Kenneth Jackson, is a process that "involve[s] the systematic growth of fringe areas at a pace more rapid than that of core cities, as a lifestyle involving a daily commute to jobs in the center" (1987, 13). Jackson notes that the distribution of populations was governed "by the desire of property owners and builders to enhance their investments by attracting the wealthy and excluding the poor" which runs parallel with the practice of segregating communities based on race by "redlining" policies (Gross, 2017).

The construction of the Interstate Highway system in 1956 also brought detrimental changes to communities of color. The construction of new roadways demolished "37,000 urban housing units each year; urban renewal and redevelopment programs were destroying an equal number of mostly low-income housing units annually" (Mohl, 2002). Urban stakeholders and business groups believed that "the removal of low-income housing and 'blighted' neighborhoods would be good for their cities" (Mohl, 2002, page 12). One pamphlet even called freeways "desirable, beneficial, and *beautiful*" to the readers of the Automotive Safety Foundation magazine (Mohl, 2002, page 19).

This history of the automobile's domination over other modes still continues to this day. More than 80% of workers in Guilford County drove to work in 2015-19. The urban core has fewer workers driving but the vast majority don't use alternative travel modes. With less available money to spend to maintain an already expensive road infrastructure, a shift in priorities is needed. Increasing pedestrian and bicycle infrastructure in cities is needed to encourage more active lifestyles, reduce air pollution and carbon emissions from vehicles, and reduce congestion and automobile dependence (Marshall, Bauer, and Frank, 2009). This type of transportation planning has been sprouting around the world in response to the rising threat of climate change. A number of European countries, as well as many American cities like Portland, Oregon, have shifted their focus away from cars, making walking and biking more attractive to commuters and residents by investing in better bike infrastructure, public transit that can take many cars off the road per load, and sidewalks that are safe to walk on and not exposed to automobile lanes (Robertson, 2019). Many places have also adopted a Vision Zero approach to transportation planning, based on the Swedish framework that aims to reduce traffic deaths and serious injuries to zero (Swedish Transport Administration, 2015). The Greensboro Department of Transportation's Vision Zero initiative deals with issues related to deaths and injuries from crashes such as increasing road safety for vulnerable users such as bicyclists and pedestrians.

This internship project seeks to locate hotspots of motor vehicle, bike and pedestrian crashes in Greensboro, North Carolina, and determine causes that contribute to the severity of the crashes. Greensboro has been leaning towards a more BiPed (short for bicycle and pedestrian) focused planning while also maintaining fast and safe access to other major cities of the state such as Charlotte, Raleigh, Durham, Wilmington, and Danville via highway. This is challenging as these two approaches to planning sometimes come into conflict



(Figure 1)

The way that roads and land use are configured can greatly increase the danger to bicyclists and pedestrians, so analyzing the crash hotspots will allow the DOT to deploy resources that will increase safety. The study timeline for this project is for the year 2019 as I helped complete that year's Quality Assurance and Quality Control process (QA/QC) for the City of Greensboro Department of Transportation's Metropolitan Planning Organization.

CHAPTER II: LITERATURE REVIEW

Section 2.1: Crash Severity Analysis

Crash severity literature is expansive, reflecting transportation agencies' concern for reducing injury severity (Li and Fan, 2019, DiMaggio, 2015, and Das and Dutta, 2020). Li and Fan (2019) use latent class clustering to study the characteristics of pedestrian crashes and their injury classes. They find that heavy vehicle weight contributed greatly to high pedestrian injuries, but note that there are limitations to this methodology. DiMaggio (2015) found that "pedestrian injury risk decreased with increasing average vehicle speed in a census tract" which can be attributed to "average vehicle speed". Das and Dutta (2020) determined several key patterns from extreme crashes including "alcohol impaired crashes with higher driver fatalities for two age groups (younger and older drivers), multi-vehicle crashes at intersection associated with an age group (31–50 years), parking related pedestrian crashes, non-deployed airbag related right angle or left turn crashes, and ROR crashes on urban two lane with no physical separation"

Section 2.2: Vision Zero

Vision Zero is a promising policy goal first proposed by the Swedish parliament in 1997 that aims to reduce the number of road traffic deaths and severe injuries to zero. One example of a Vision Zero policy is Portland, Oregon's speed management project that seeks to lower speeds on roads where crashes commonly occur. Researchers found that most crashes occurred on roads with a posted speed limit sign between 35mph and 45mph. These roads containing the majority of crashes accounted for 235 miles of the city centerlines, and 45% of the city's High Crash Network (Vision Zero Network, 2018). While planners understand the impossibility of eliminating all traffic crashes, they see a possibility to increase road safety so that crashes are less damaging, costly, and deadly. One outstanding case of defying the "impossible", Oslo, Norway saw zero bicycle and pedestrian fatalities in 2019. The main causes of their amazing success include "more bike infrastructure, lower speed limits, fewer vehicles on the road overall, less traffic in residential areas, speed bumps, vehicles equipped with better technology, and better roads in general" along with implementing "heart zones" around primary schools where no vehicles may pick up children (Coulon, 2020). The case study on Portland listed three specific strategies that the Portland Bureau of Transportation (PBOT) pursued to reduce deaths resulting from car crashes. They start with a formal proposal, an Alternative Speed Zone Investigation, to lower a street's speed limit by investigating the street context including land use, facilities for people walking and biking, crash history, and recommended speeds that would protect people walking and biking. Matthew Ferris-Smith, one of the Vision Zero Specialists at the PBOT, said that "Portland can't redesign all of its roads now, but by lowering speed limits, we can lower the public's expectations for high speed and begin to change the broader culture of speeding." (Vision Zero Network, 2018).

PBOT's second strategy is to design streets to encourage safe speeds. They use various indicators and metrics to rank intersections and road segments that fall within the High Crash

Network (HCN) and cross references with their composite of 10 equity indicators to prioritize project funding. Portland currently has a higher speed limit in a majority of their roadways which is contributing to deaths resulting from crashes. The characteristics that their Decision Matrix lists as important for shared roadways of less than or equal to 30mph are sidewalks on both sides of the curb or swale, and 8' separation for pedestrians. The amount of space for bike lanes on a shared roadway at or below 30mph is 6'-7' bike lanes. Finally, PBOT also maximizes proven technology such as speed cameras, which are proposed to be placed at areas of high crash corridors. PBOT has also explored allowing low-income offenders to take driver safety education classes instead of paying a fine.

Section 2.3: Non-Motorized Transportation

Walking and bicycling have become more popular as modes of travel because of their health benefits, lower cost, and lower environmental impacts (Marshall, Brauer, and Frank, 2009). How the built environment is planned can greatly influence walking and bicycling habits by providing recreational and transportation benefits to the community (Zuniga-Teran et al., 2016). In a qualitative study of pedestrian perceptions, attitudes, and behavior in Tucson, Arizona, Zuniga-Teran et al. (2016) find that the most significant motivations for walking were traffic safety and land use. They conclude that:

> [W]alkable neighborhoods should provide safe infrastructure to pedestrians and cyclists and employ traffic-calming treatments to encourage physical activity regardless of the

motivation of walking. In addition, walkable neighborhoods must include a mix of land uses (a variety of shops and restaurants close to homes) to encourage walking for both recreation and transportation. (71)

Indices are used to measure pedestrian and bicycle friendliness by studying various variables that can contribute to a better score that represents the concept that is being focused on such as walkability or bikeability. The Environmental Protection Agency has also created a national walkability index using variables such as employment types, street pedestrian-oriented intersection density, and a predicted commute mode split (including carpooling) in order to rank block groups by their estimated walkability. A map of localized walkability scores in Greensboro, North Carolina can be seen in Figure 29.

Aside from Porter et al. (2020), there have not been many bikeability indices in a standard North American city. There have been a few indices created for American cities (Ma and Dill, 2017, and Winters et al., 2013). Castañon and Ribeiro's (2021) exploratory analysis on bikeability indices found that the vast majority of indices focus on bicycle infrastructure and "rarely integrate environmental, health, and technological innovation issues" for cyclists (Castañon and Ribeiro, 2021, page 17). They also note that bike parking is rarely included in bikeability indices despite its importance to bikeability. Another shortcoming of bikeability indices is that they rarely, if ever, factor in bike- or scooter-sharing services which have become popular in the past decade.

Understanding the crash literature is important for planners to conduct analyses that take into account the current trends and patterns associated with crashes. To summarize, the built environment and its characteristics can have a large part of increasing crash severity. Higher speeds, Biking and walking have become more popular as a transportation mode and increasing accessibility of these modes by implementing BiPed infrastructure will lower car-dependency thus lowering the chances of severe or fatal crashes. GDOT has a vision zero initiative and have proposed 134 bike lanes and 10 protected bike lanes in the 2015 BiPed Plan Update. These proposals total 334 new miles of bike lanes and 167 centerline miles. This is a good step forwards to bettering current trends of crashes.

CHAPTER III: METHODOLOGY

Section 3.1: Project Overview

The project sought to discover patterns surrounding the crashes that occurred in the year 2019. GIS was used to map spatial patterns of different crashes by mode (automobile, bicycle, and pedestrian) and by severity ratings. This data was not ready to use when the project began and had to be formatted and completed in order to conduct the GIS analyses.

Section 3.2: Data Preparation and QA/QC Process

First, the quarterly crash data spreadsheet prepared by the Greensboro Police Department's GIS Analyst is checked, transferred into a geographic information system (GIS), automatically geocoded using the City of Greensboro's address locator, and compiled into monthly counts. Because automatic geocoding is typically imprecise, it must be supplemented with manual crash report analysis for better accuracy.

Once the PDFs are ready, the GIS work can begin. As crash points are plotted to their actual locations, data values must be checked in the attribute table. The most important variable is the vehicle type (car, pedestrian, bicycle, moped, scooter, etc.). Other important variables that must be completed are the cause of crash, crash severity, and cost of damages from the insurance companies.

Once all of the crash points have been accurately geocoded, the attribute table is comprehensively reviewed to ensure that all data is present. Some months have large swaths of data missing that need to be checked manually in the crash reports. After all data has been checked and verified, X and Y coordinates are recalculated.

The final step is to export the shapefile into a feature class and put it into the larger geodatabase that the interns share with the engineer in charge of crash data. Once the export has occurred, then the feature class is checked by the engineer. If anything is amiss, the engineer gives an update on next steps to fix the problem.

Once the year's crash data is together and exported to the completed geodatabase, then the process for quality assurance and quality control (QAQC) begins. All monthly data is merged into one master file for the entire year and then checked to ensure that all data is successfully combined. Any missing data is re-inputted into the attribute table. When this is complete, the engineer gives a final check through the feature class and completes the QAQC process. This feature class is exported to its final location in the department geodatabase.

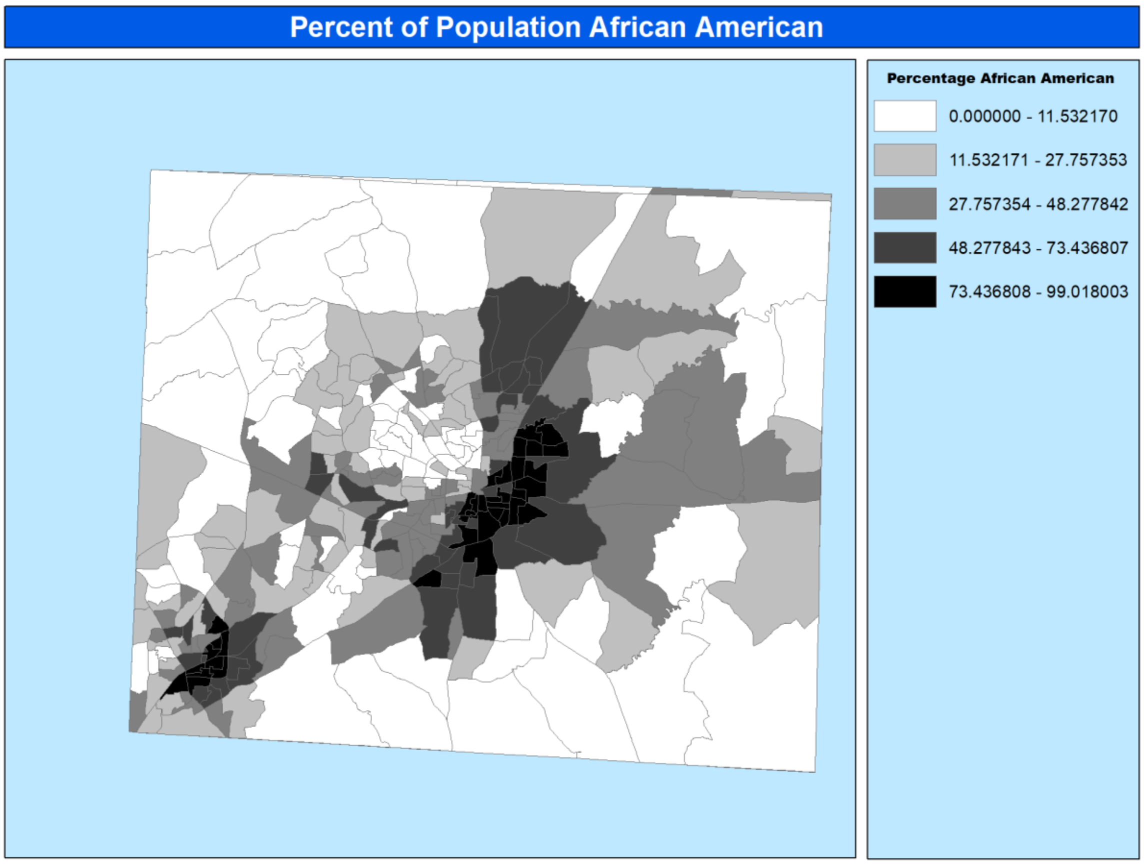
Section 3.5: Analysis

Usually, five years of data are combined to analyze crash patterns and assess the success of any road projects or modifications in reducing crashes and crash severity. However, only 2019 crash data was used in the following analysis due to different objectives. This analysis is based on two main GIS data sources. The first contains every crash that occurred in 2019, a total of

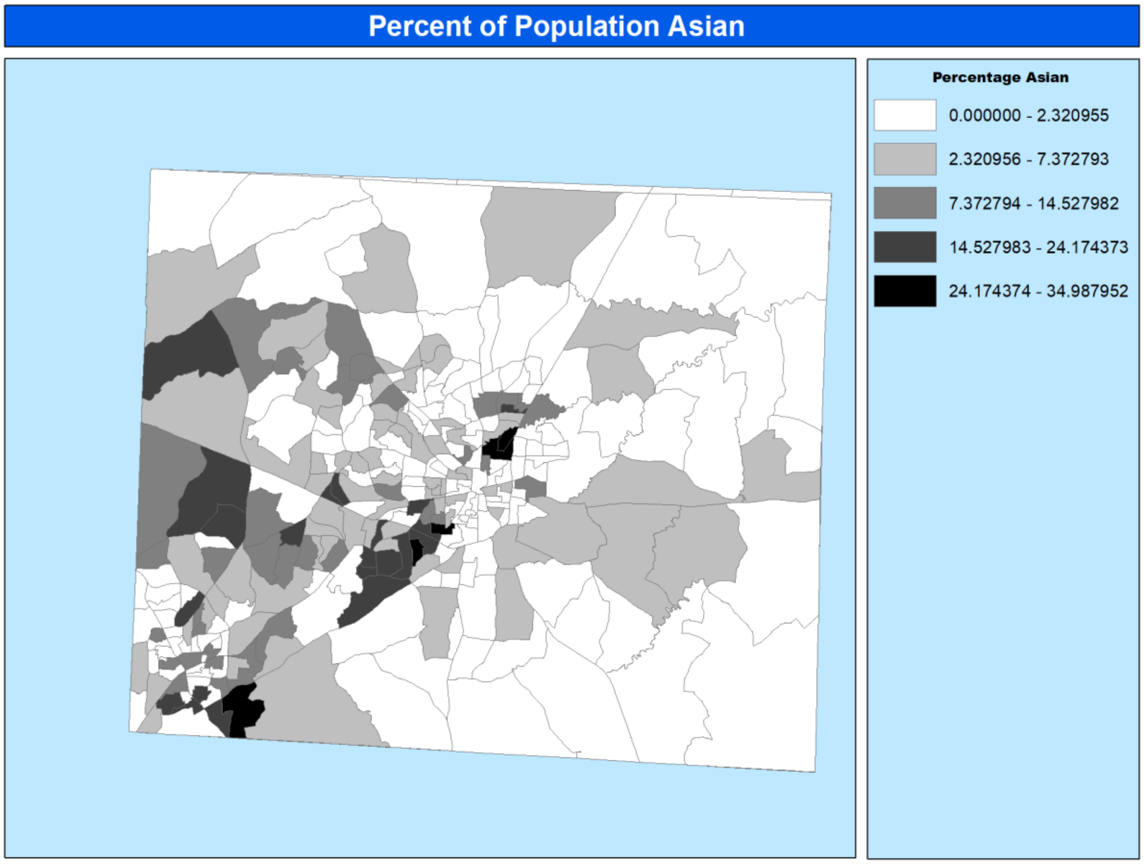
10,512. The second is a subset containing just bicycle or pedestrian-related crashes totaling 177 (2% of crashes).

Section 3.5.1: Background Data

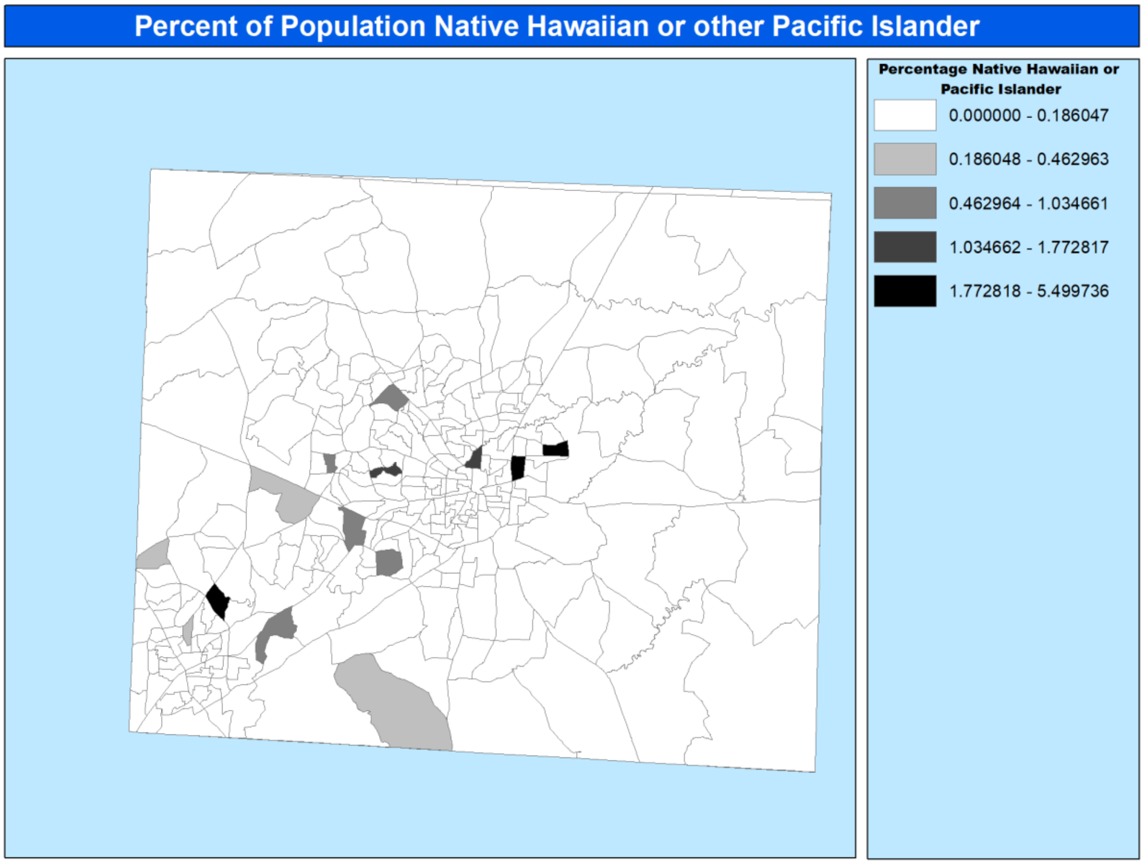
The next analysis that I performed for this project was a choropleth map of Census demographic and economic data by census tract for Guilford County. Figure 2 shows the percentage of census tracts that are African American, figure 3 shows the percentage of census tracts that are Asian, figure 4 shows the percentage of census tracts that are Native Hawaiian or other Pacific Islander, figure 5 shows the percentage of census tracts that are Hispanic, and figure 6 shows the percentage of census tracts that are Native American.


Percent of Population African American
Percentage African American
0.000000 - 11.532170
11.532171 - 27.757353
27.757354 - 48.277842
48.277843 - 73.436807
73.436808 - 99.018003

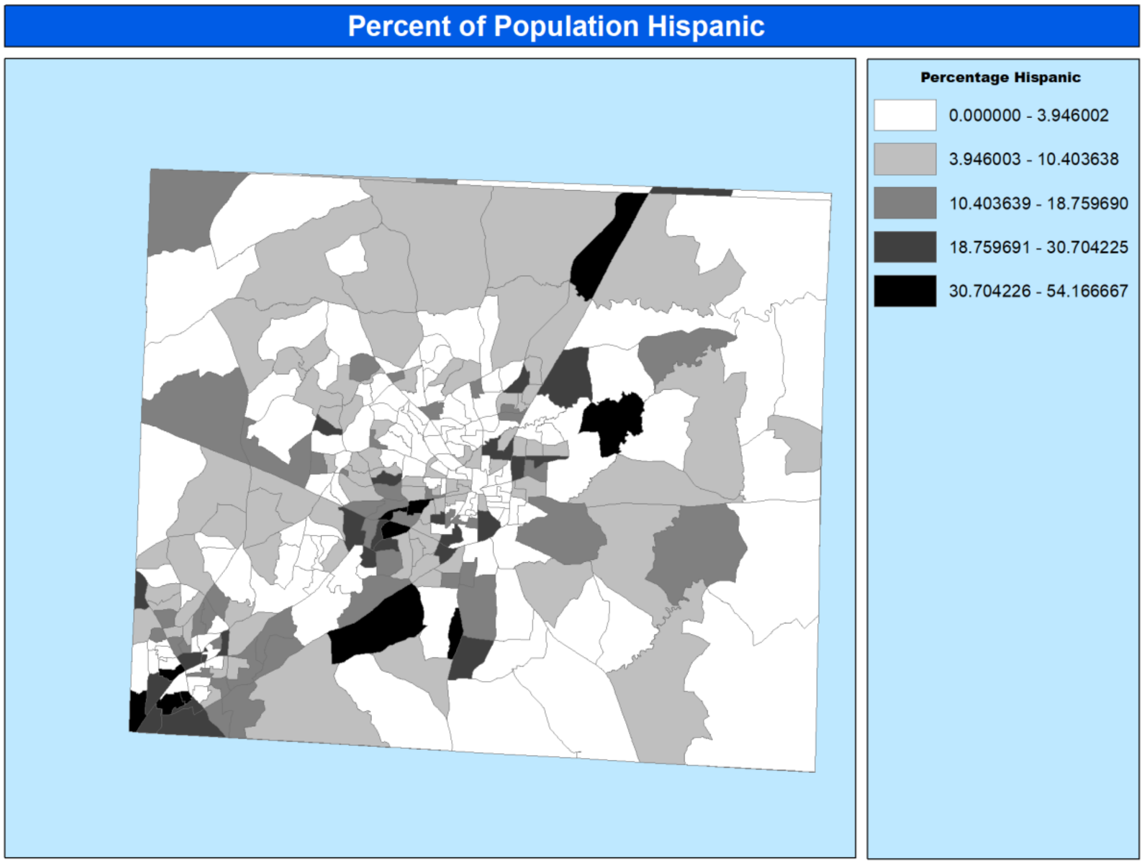
(Figure 2)


Percent of Population Asian
Percentage Asian
0.000000 - 2.320955
2.320956 - 7.372793
7.372794 - 14.527982
14.527983 - 24.174373
24.174374 - 34.987952

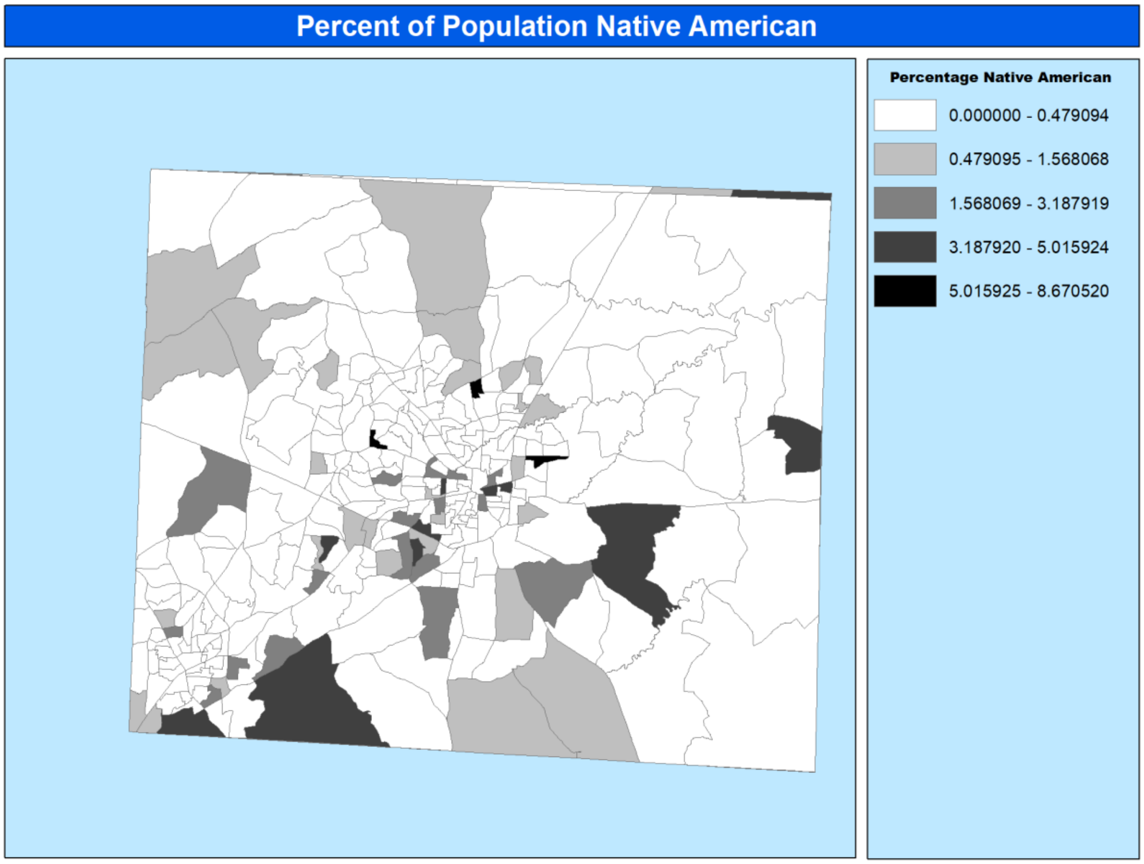
(Figure 3)


Percent of Population Native Hawaiian or other Pacific Islander
Percentage Native Hawaiian or Pacific Islander
0.000000 - 0.186047
0.186048 - 0.462963
0.462964 - 1.034661
1.034662 - 1.772817
1.772818 - 5.499736

(Figure 4)

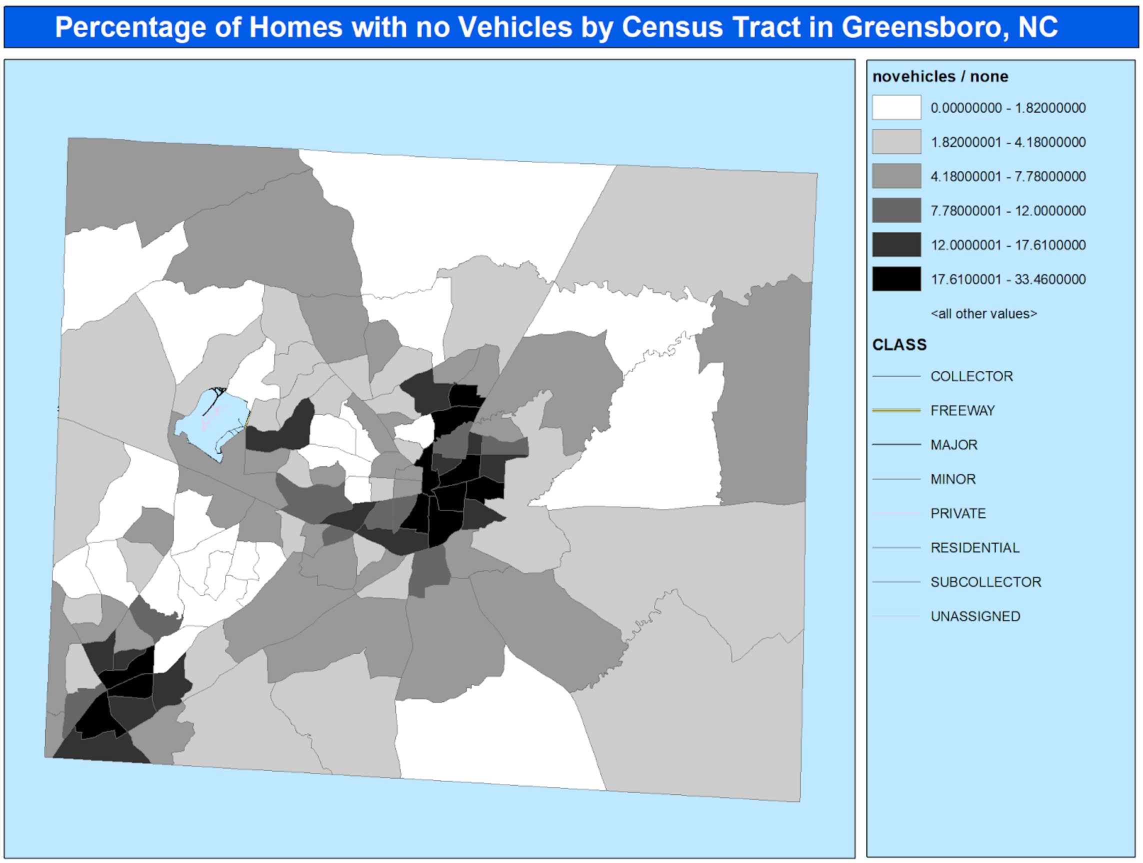

Percent of Population Hispanic
Percentage Hispanic
0.000000 - 3.946002
3.946003 - 10.403638
10.403639 - 18.759690
18.759691 - 30.704225
30.704226 - 54.166667

(Figure 5)

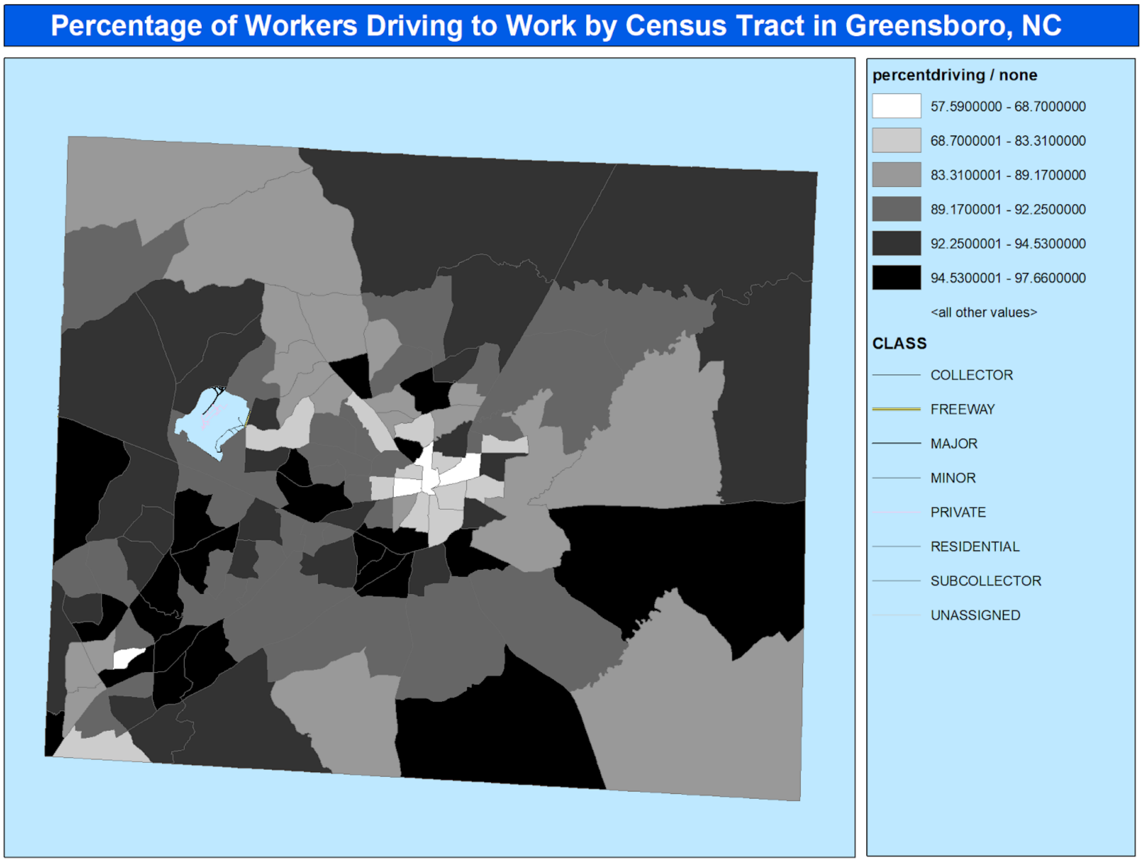


(Figure 6)

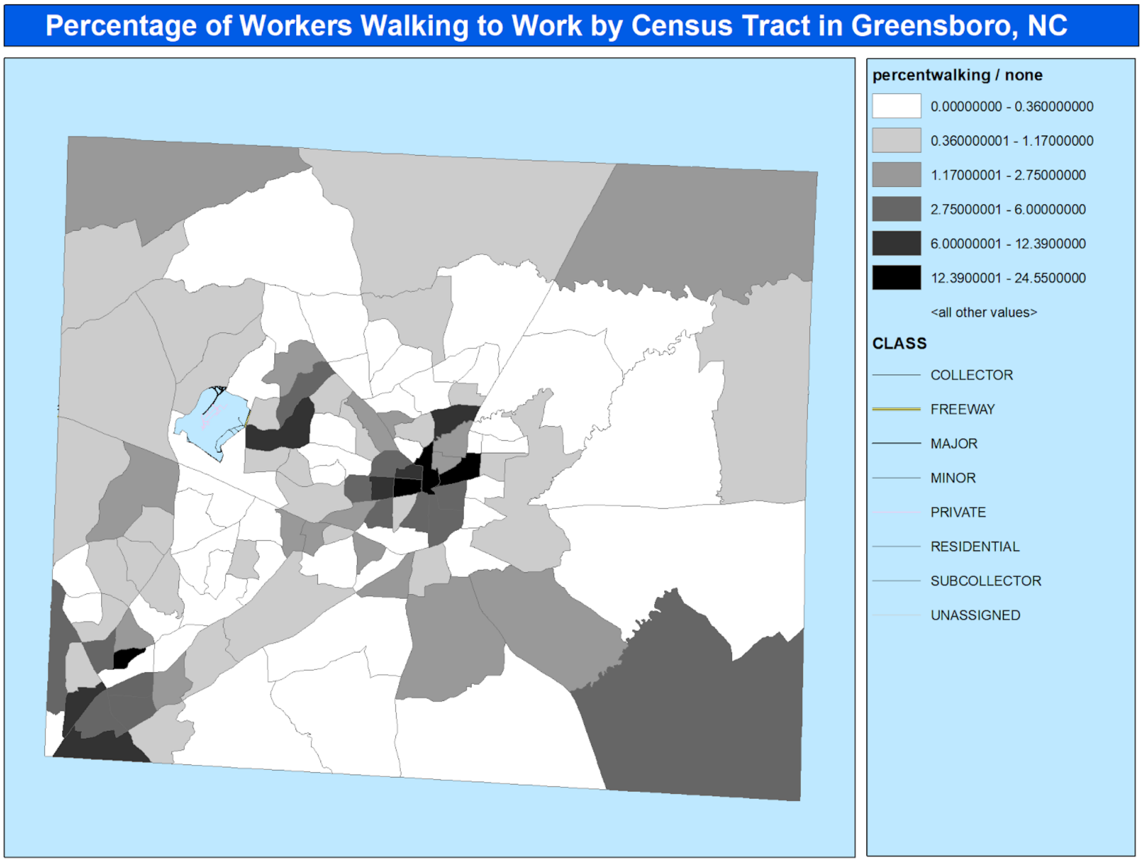
The median household income for this Guilford County is $51,803 (see https://datausa.io/profile/geo/guilford-county-nc#:~:text=Median%20household%20income%20in%20Guilford,values%20of%20%24123%2C875%20and%20%24119%2C479.) but figure 30 shows median household income by census tract. Figures 7-10 displays household vehicle access, and the percentage of workers who drive, bike, or walk to work.


Percentage of Homes with no Vehicles by Census Tract in Greensboro, NC
novehicles / none
0.00000000 - 1.82000000
1.82000001 - 4.18000000
4.18000001 - 7.78000000
7.78000001 - 12.0000000
12.0000001 - 17.6100000
17.6100001 - 33.4600000
<all other values>
CLASS
COLLECTOR
FREEWAY
MAJOR
MINOR
PRIVATE
RESIDENTIAL
SUBCOLLECTOR
UNASSIGNED

(Figure 7)


Percentage of Workers Driving to Work by Census Tract in Greensboro, NC
percentdriving / none
57.5900000 - 68.7000000
68.7000001 - 83.3100000
83.3100001 - 89.1700000
89.1700001 - 92.2500000
92.2500001 - 94.5300000
94.5300001 - 97.6600000
<all other values>
CLASS
COLLECTOR
FREEWAY
MAJOR
MINOR
PRIVATE
RESIDENTIAL
SUBCOLLECTOR
UNASSIGNED

(Figure 8)


Percentage of Workers Walking to Work by Census Tract in Greensboro, NC
percentwalking / none
0.00000000 - 0.360000000
0.360000001 - 1.17000000
1.17000001 - 2.75000000
2.75000001 - 6.00000000
6.00000001 - 12.3900000
12.3900001 - 24.5500000
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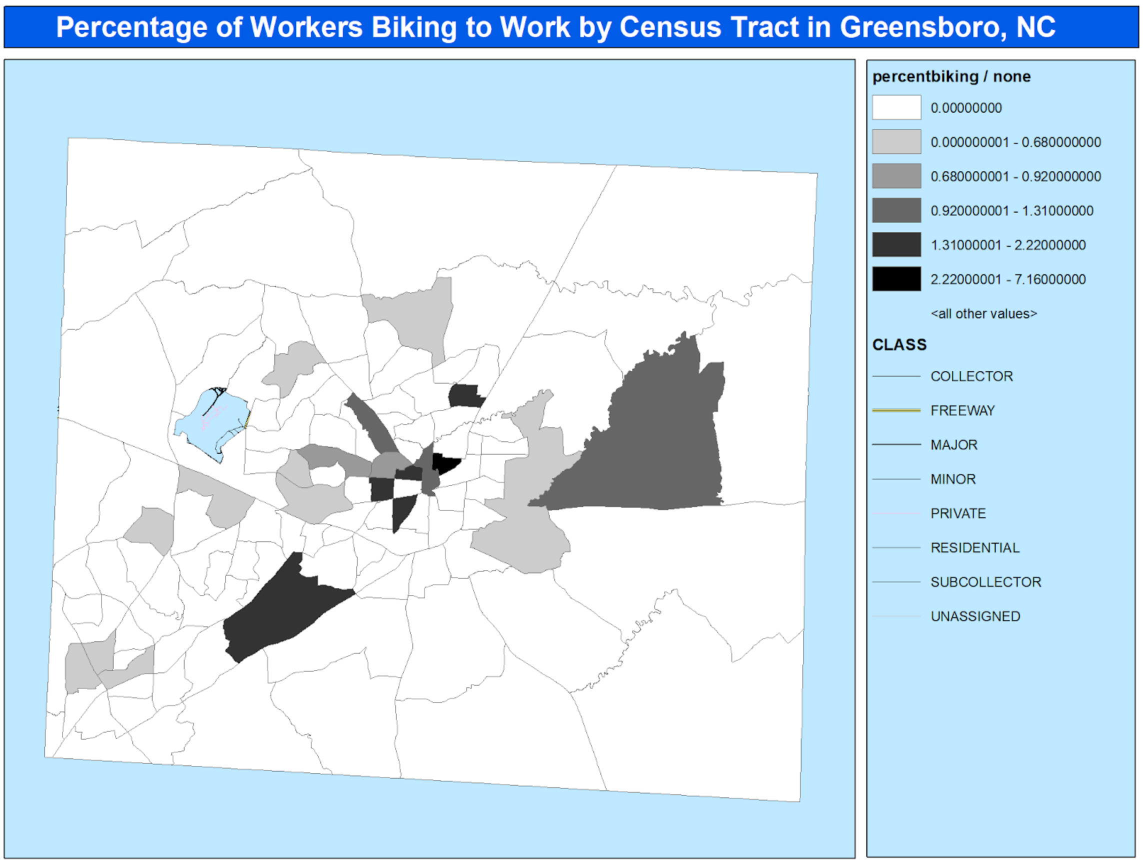
CLASS
COLLECTOR
FREEWAY
MAJOR
MINOR
PRIVATE
RESIDENTIAL
SUBCOLLECTOR
UNASSIGNED

(Figure 9)



(Figure 10)

Section 3.5.2: Kernel Density Analysis

The first crash data analysis that was performed was a kernel density analysis to understand the general density of crashes in the Greensboro Urban Area. Kernel density analysis calculates a magnitude-per-unit area from points or polylines to highlight areas of high density. I used the kernel density analysis to find areas of high concentrations of fatal crashes, Class A injuries, Class B injuries, and Class C injuries (see Table 1 below).

Table 1. Injury types and characteristics

Type of Injury	Description
Fatal	Any injury that results in death within 12 months after the crash occurred
Class A	An injury obviously serious enough to prevent the injured person from performing his or her normal activities for at least one day beyond the day of the crash. Massive loss of blood, broken bone, unconsciousness of more than momentary duration are examples
Class B	Obvious injury, other than a fatality or A Type injury, which is evident at the scene. Bruises, swelling, limping, soreness, are examples. This injury would not necessarily prevent the person from carrying on his or her normal activities.
Class C	No visible injury, but the person complains of pain, or has been momentarily unconscious.

All crashes were mapped together and separately to analyze the patterns of crash severity of each mode of transport. Figure 13 shows overall severity patterns, Figure 15 displays only biped-related severity, Figure 22 shows pedestrian-related crash severity with the Guilford County Walkability Index derived from the EPA dataset, and finally Figure 25 displays bike-related crash severity.

Section 3.5.3 Hotspot Analysis of Bicycle, Pedestrian, and Car Crashes

The second analysis I performed was a hotspot analysis using ArcGIS's hotspot analysis tool. This analysis locates hotspots, or areas that have a high prevalence of a given variable, so that they can be seen more easily. For this project I performed a Getis-Ord Gi* statistic because it allows the user to locate both cold and hot spots of the chosen variable, in this case crash severity. The first hotspot analysis done was for car crashes only. The car crashes were not normalized with traffic volume.

To conduct a hotspot analysis of bicycle and pedestrian crashes requires normalizing the data using MioVision traffic count data. MioVision is a platform that allows transport agencies to count pedestrians and bicycles passing specific intersections from 7am to 7pm. That is the chosen time frame due to the majority of walking and biking traffic occurring during this time. To normalize the data, bicycle and pedestrian crash counts were separated into separate layers and spatially joined to a quarter-mile buffer around each MioVision station. These stations provide bicycle and pedestrian volume estimates needed to calculate hotspots and coldspots for bicycle and pedestrian crashes. Although the timeframe for these counts presents a limitation in the data, since there were bicycle and pedestrian crashes outside of the 12-hour count period, they provide a reasonable baseline.

CHAPTER IV: RESULTS

Section 4.1: Descriptive Statistics

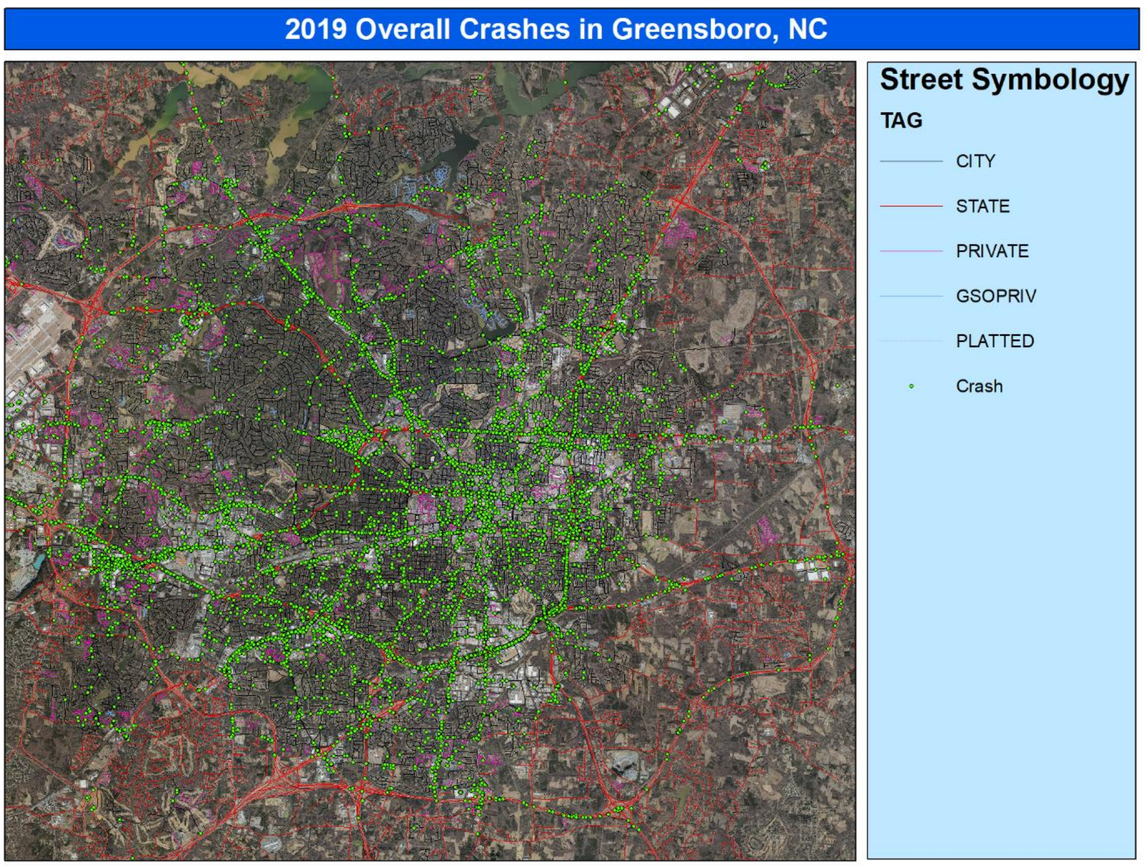
Table 2. Descriptive statistics

Class Type	**Raw Numbers**	**Percentage**
Fatal	6	.05%
Type A (serious injuries)	13	.12&
Type B (obvious injuries)	445	4%
Type C (nonvisible injuries)	2711	25.7%
No injuries	6929	65.7%
Not Recorded	33	.3%
Unknown	414	3.9%
Total Crashes without Injury Type	447	4.2%
Total Crashes	10,545	

Based on these statistics, the following observations can be made. First, roughly 8% of crashes were not assigned an injury rating or the injuries were unknown. Second, thankfully, fatal crashes only make up .05% of the crashes for the 2019 year, which is quite lower than the 10-15 fatal crashes' average for the last two decades. Third, the majority of crashes (65%) resulted in no injuries. That figure may likely be higher once factoring in crashes without injury ratings.

Section 4.2 Kernel Density of All Crashes and Their Injury Ratings

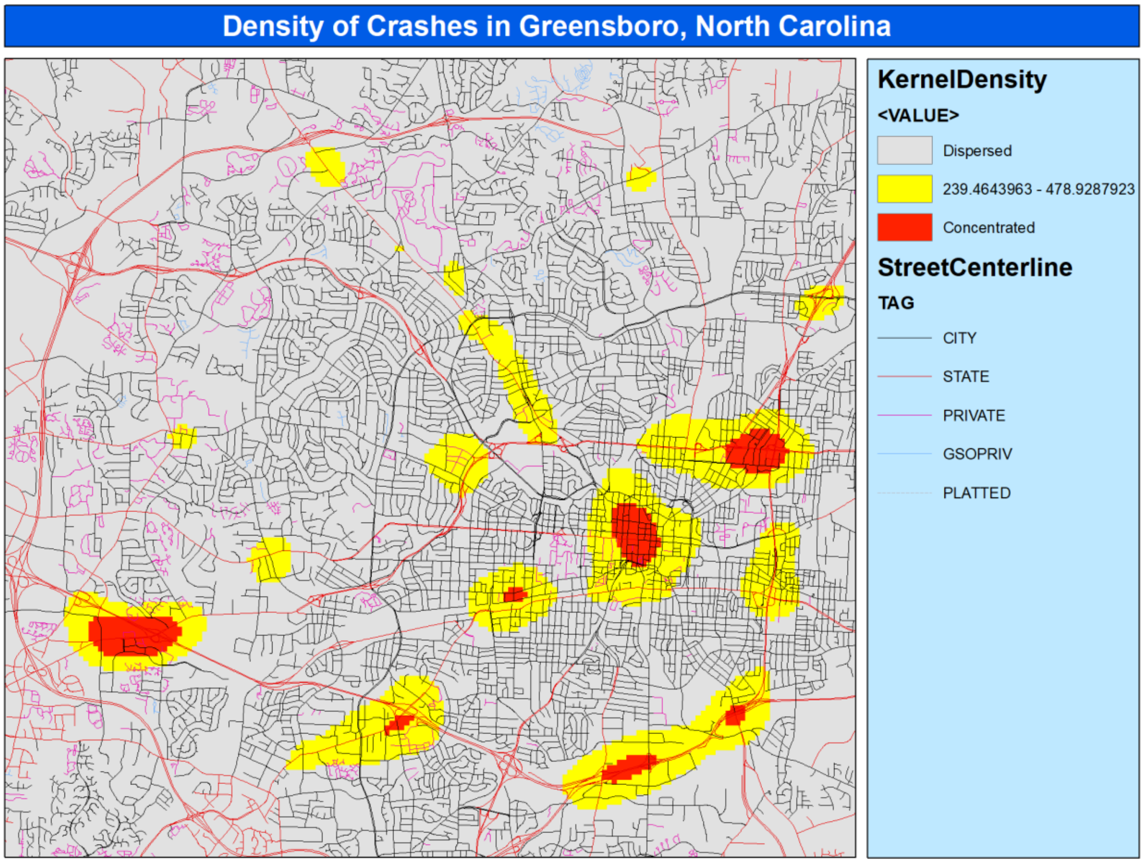
Figure 11 shows all the crashes that occurred in 2019. This map is important to have before doing the kernel density because it allows hypotheses to be made about what the kernel density maps will display.



(Figure 11)

The kernel density analysis yielded interesting but not unexpected results. The six concentrated areas of crashes, as shown in Figure 12, tended to be major intersections and highways. Notable crash areas include:

- The West Wendover Ave segment ranging from Bridford Parkway to Big Tree Way in southwest Greensboro
- The intersection of West Gate City Boulevard and Pinecroft Rd
- The I-40 West/Business 85S corridor between S Elm/Eugene St and Randleman Rd
- The intersections of Martin Luther King Jr Dr with 1-40 East/Bus 85 and I-40 West/Bus 85N
- The intersection of Spring Garden and Warren streets



(Figure 12)

These multi-lane streets and highways have speed limits between 45mph and 65mph and wider lanes, resulting in drivers not adhering to the speed limits. Some of these areas are also subject to low visibility at sunrise and sunset, making merging and changing lanes a gamble for drivers.

Figures 13-17 display crash types and where they are concentrated**.** These crashes contain all vehicle types (automobile, pedestrian, bicycle). Fatal crashes were concentrated in the southwestern portion of Greensboro. Figure 9 suggests that Type A injuries occur at the meeting points of Highway 421 and I-40 East and Business 85 and Martin Luther King Jr Dr. Crashes that resulted in Type B (obvious) injuries are shown in Figure 15 and are concentrated in the Downtown area along Bellemeade Street, Friendly Avenue, and Market Street. Type C (nonvisible) injuries are clustered in four different areas:

- the intersecting point of West Wendover Avenue and I-40
- I-40West/Business 85 South from Randleman Road to Martin Luther King Jr Drive
- the downtown area around the intersection of N Edgeworth St and Bellemeade St.,
- W Wendover Ave/E Bessemer Ave from Summit Ave to US 29 N (Figure 16).

Finally, the highest concentration of no-injury crashes is on W Wendover Ave between Bridford Parkway and I-40 E (Figure 17).

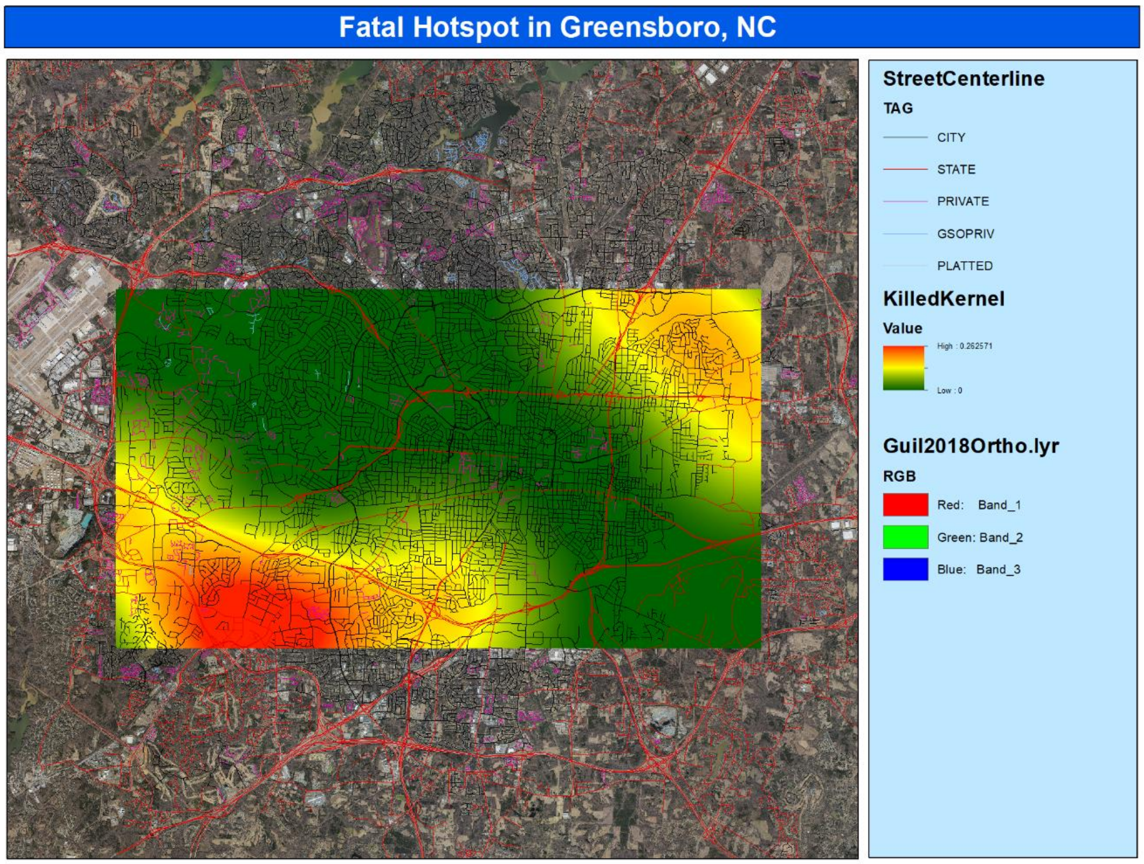
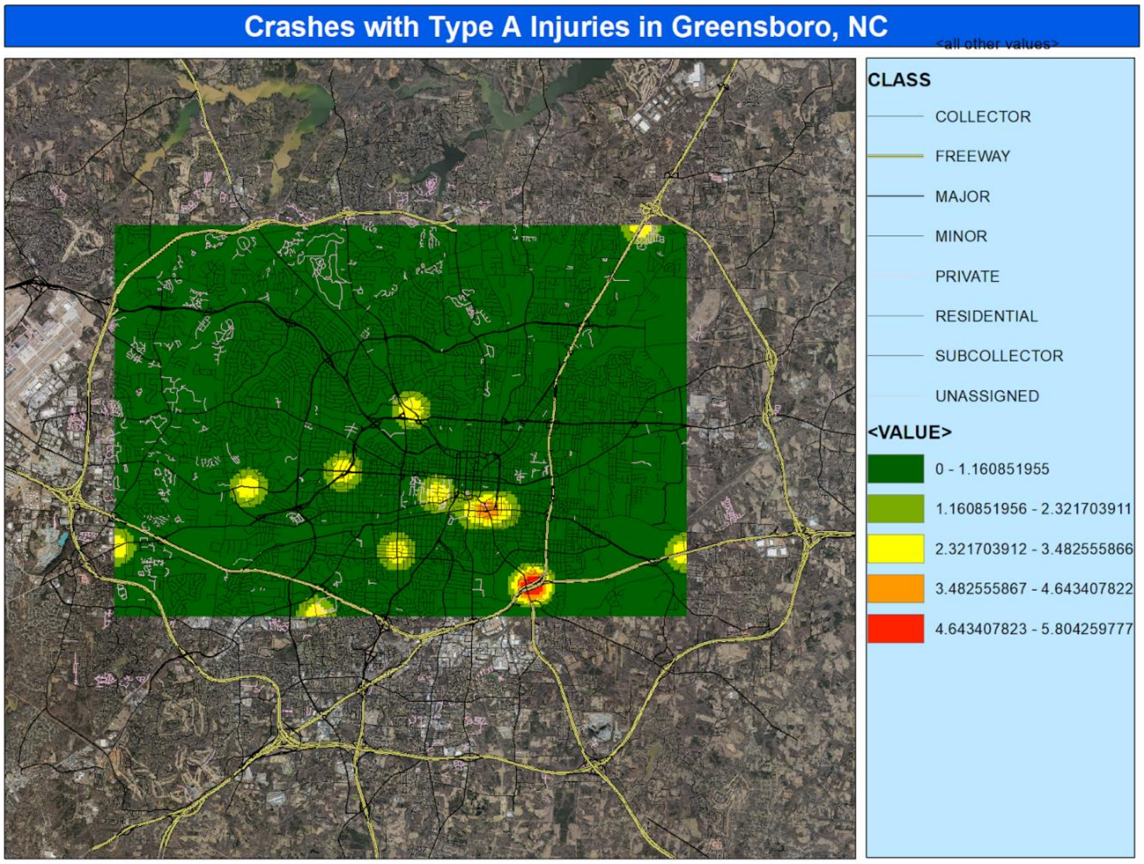

Fatal Hotspot in Greensboro, NC
StreetCenterline
TAG
CITY
STATE
PRIVATE
GSOPRIV
PLATTED
KilledKernel
Value
High : 0.262571
Low : 0
Guil2018Ortho.lyr
RGB
Red: Band_1
Green: Band_2
Blue: Band_3

Figure 13


Crashes with Type A Injuries in Greensboro, NC
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MAJOR
MINOR
PRIVATE
RESIDENTIAL
SUBCOLLECTOR
UNASSIGNED
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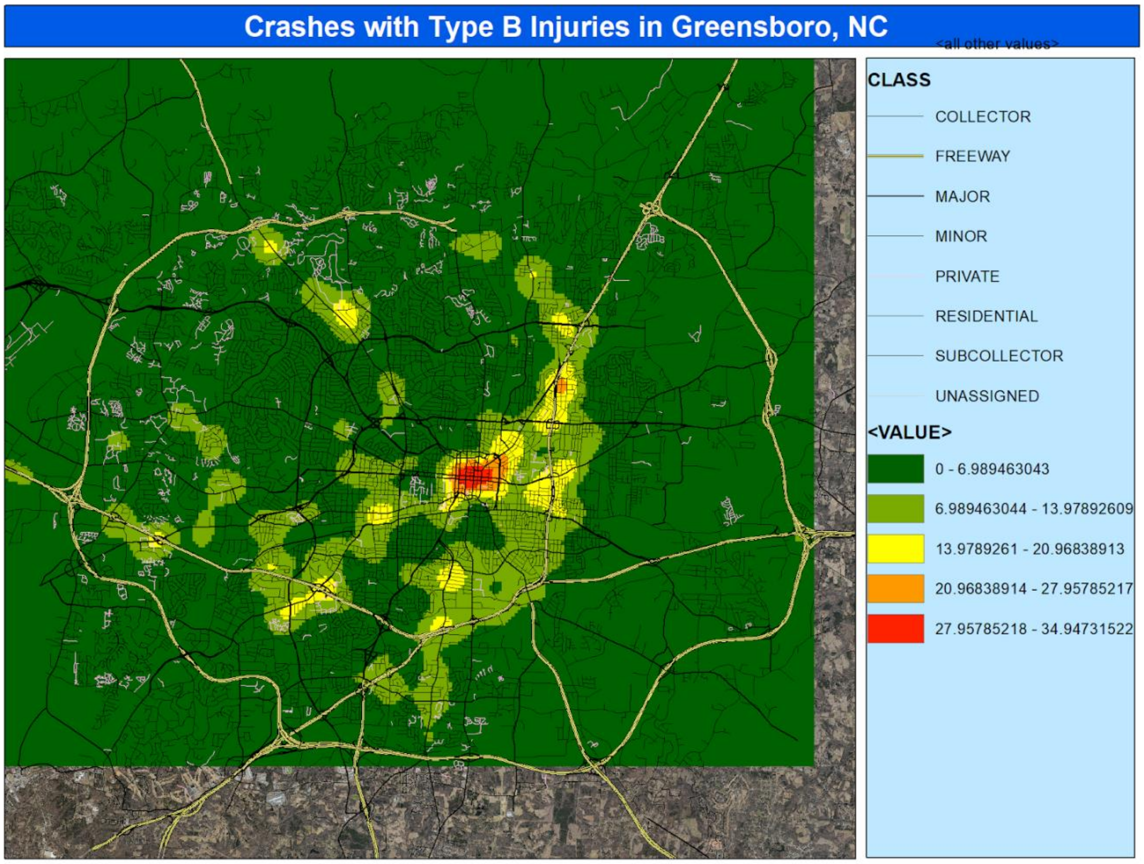
1.160851956 - 2.321703911
2.321703912 - 3.482555866
3.482555867 - 4.643407822
4.643407823 - 5.804259777

Figure 14


Crashes with Type B Injuries in Greensboro, NC
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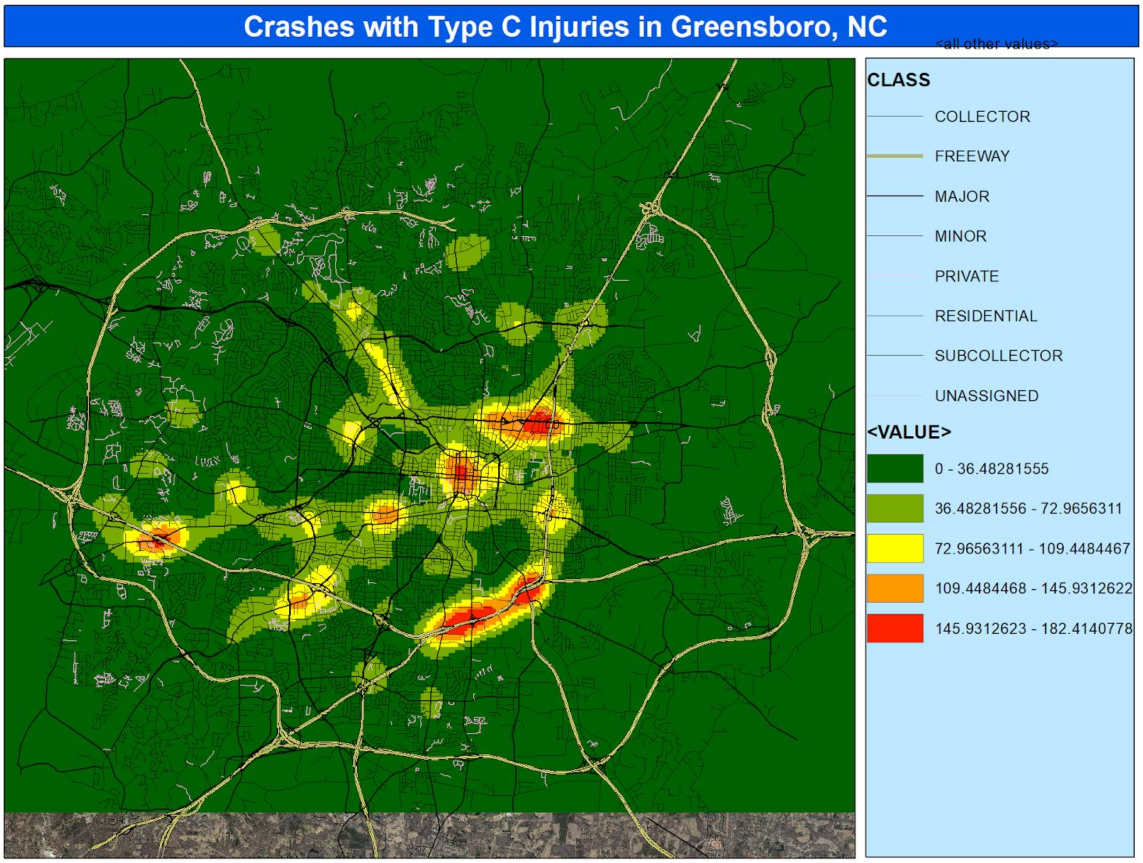
13.9789261 - 20.96838913
20.96838914 - 27.95785217
27.95785218 - 34.94731522

Figure 15


Crashes with Type C Injuries in Greensboro, NC
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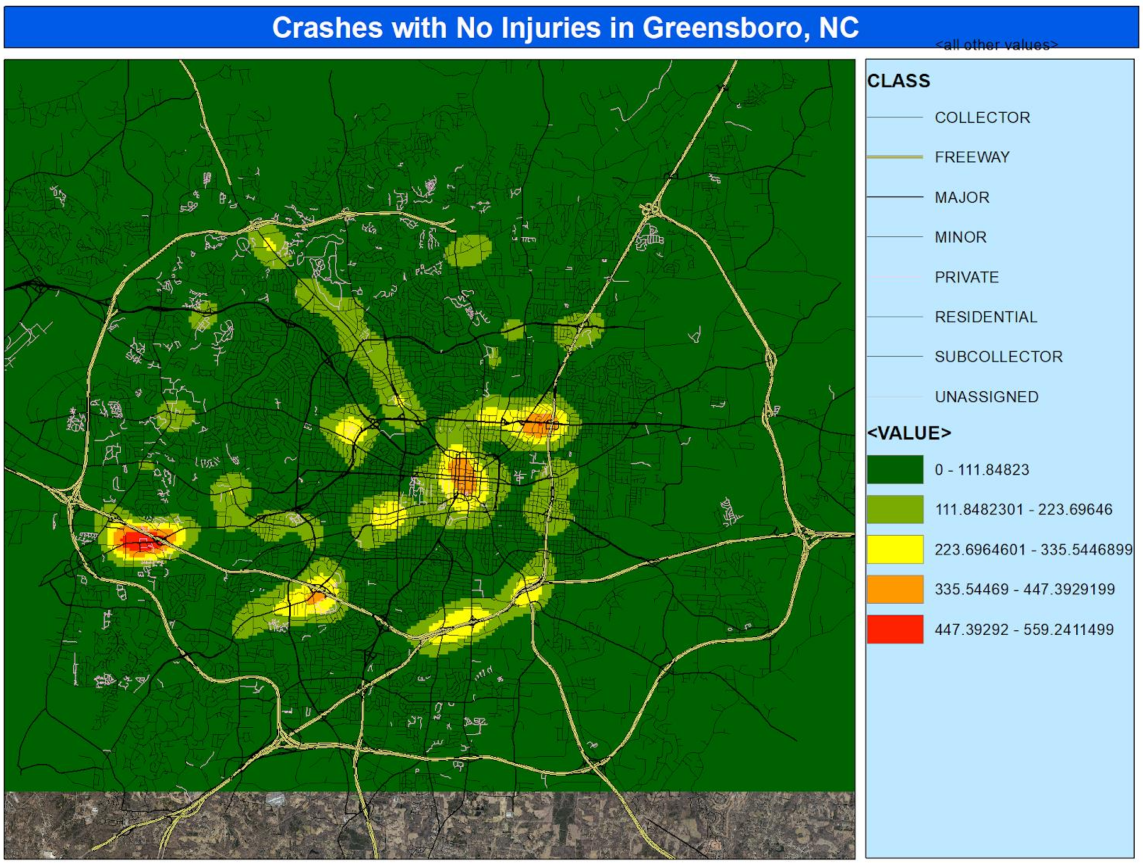
145.9312623 - 182.4140778

<u>Figure 16</u>



(Figure 17)

Figure 18 displays the hotspots and low spots of the severity ratings of all crashes. It should be noted that the low spots (in blue) are the lowest severities meaning no injuries. The hotspots in this map display the high severity (severe injury).

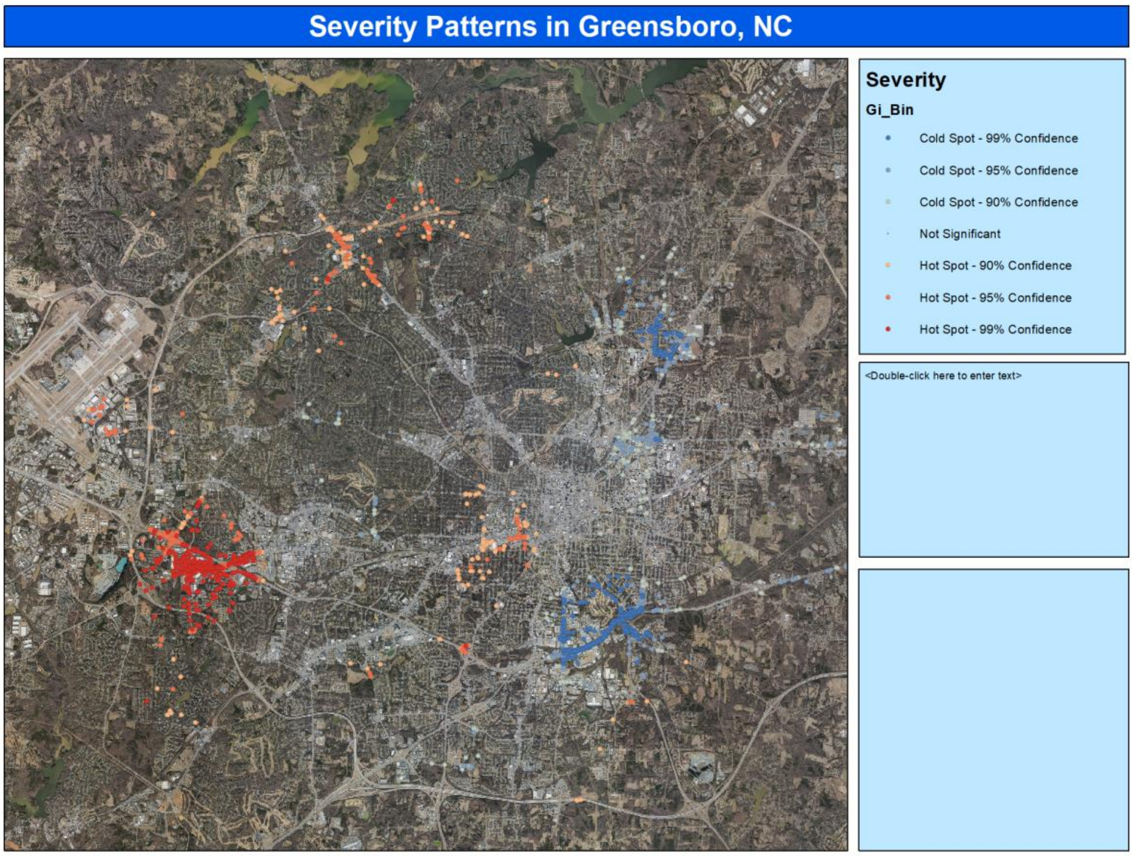


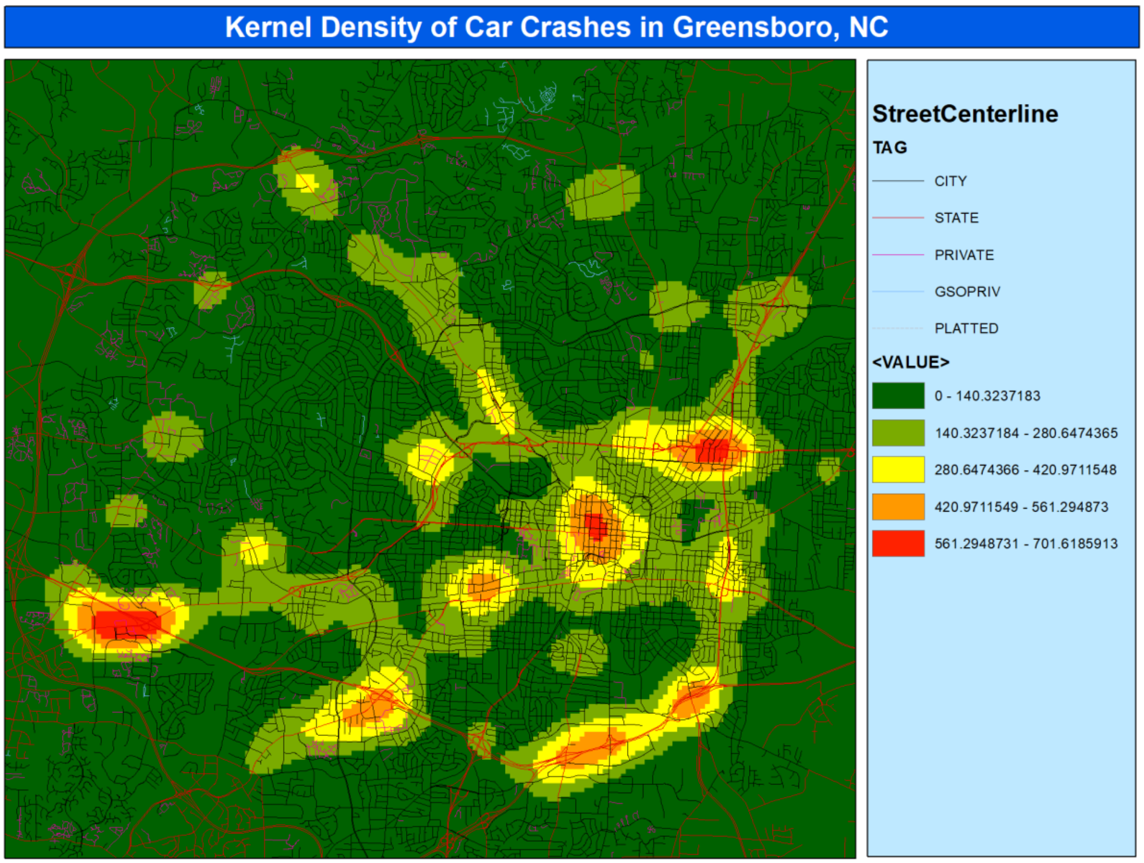
Figure 18

In summary, hotspot analyses were performed and areas of high prevalence of crashes paired with their injury ratings were mapped. What's interesting about these maps is that the lower severity crashes happened in high volume, high speed areas in Greensboro. The higher severity crashes also occurred in high volume and speed areas.

Section 4.4: Automobile-Related Crash Patterns

The first analysis tool that I used was the kernel density toolkit previously noted except it only uses car crash data. This shows many different areas of concentrated car crashes. The resulting map of this is in figure 19. There are a total of 3 areas of concentration where car crashes occur;

- US Highway 29/W Wendover Avenue
- West Wendover Avenue from I 40 W on-ramp to Hilltop Trail
- The Downtown area that is bordered by Bellemeade Street/North Edgeworth Street/West Sycamore Street/John Wesley Way leading into Commerce Plaza.



(Figure 19)

One contributing factor to automobile crashes in the area of Wendover Avenue East and US Highway 29 is the many on- and off-ramps that are not conducive to merging onto Wendover. Figure 20 shows the challenges drivers face merging into three lanes of 45-mph traffic from a short, inclined merging lane. Many of the crashes that occur here are rear-ends. Some adjustments to these roads, such as lowering speed limits or constricting lane widths, would be very beneficial. Another potential way to lower the number of crashes would be to put a stop light at the midpoint between the onramp and the off-ramp of US 29 Southbound. GDOT's US 29 Access and Safety project seeks to consolidate on and off ramps and close ten at-grade access points to US 29 in response to the large quantities of crashes. The proposed alternatives to US 29 can be seen in Figures 21-23.

Figure 20


Begin Project
Remove section of Ramp
Remove access to US 29 SB
Remove access to US 29 NB
US 29
DUKE
GATE CITY
GORRELL
O HENRY
MCCONNELL
HACKETT
LINCOLN
GILLESPIE
WILLOW HOPE
PICHARD

Figure 21


Remove access to & from US 29
Remove section of Ramp
Close access
Connect Meadow St. to frontage road
Close Access
Close access
Close access
New frontage road
US 29
O HENRY
WENDOVER
BESSEMER
HEADQUARTERS
TUCKER
HUFFMAN

Figure 22

Figure 23

To locate intersections with high rates of pedestrian-related crashes, I used the ArcGIS's Optimized Hot Spot Analysis tool. Four intersections in Greensboro had a high rate of pedestrian-related crashes (Figure 24). Three of these were located along West Wendover Avenue at the intersections of Bridford Parkway, Landview Drive, and the I-40 exit ramp. Some likely reasons for this are that Wendover is very busy, with few cross walks except at each of the intersections and high speed limits. The other intersection with a high rate of car-pedestrian crashes was located at Muirs Chapel Road and Cannon Road which might be due to the lack of sidewalks on the residential side of the street running along Muirs Chapel Road.

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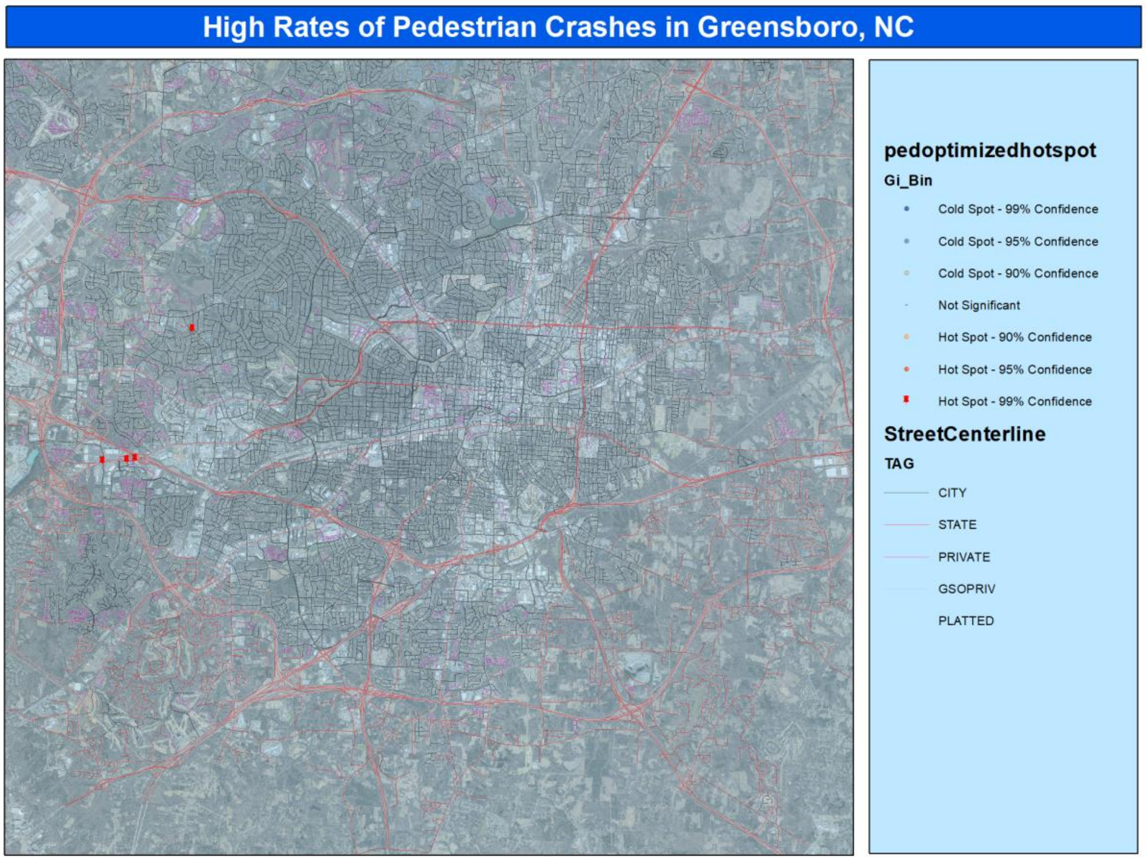


Figure 24

Figure 25 shows the walkability values for Greensboro by census tract. Figure 26 displays walkability in Greensboro along with the four intersections of high pedestrian-related crashes. Figure 27 shows the walkability of Greensboro with pedestrian severity levels of each crash displayed. Figure 28 displays the location of all pedestrian and bicycle crashes in Greensboro along with the locations of all MioVision stations. Figure 29 shows bicycle and pedestrian-related severity. Figure 30displays all pedestrian-related crashes and their severity classifications.

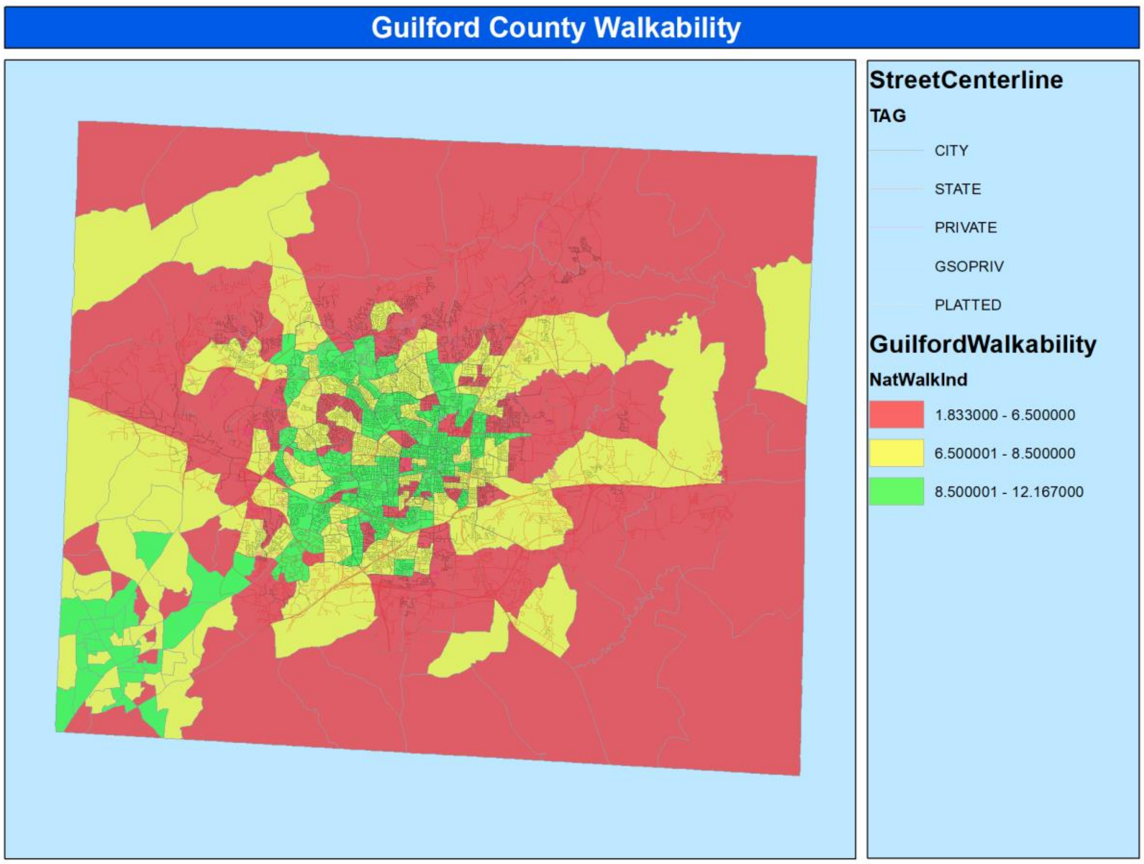
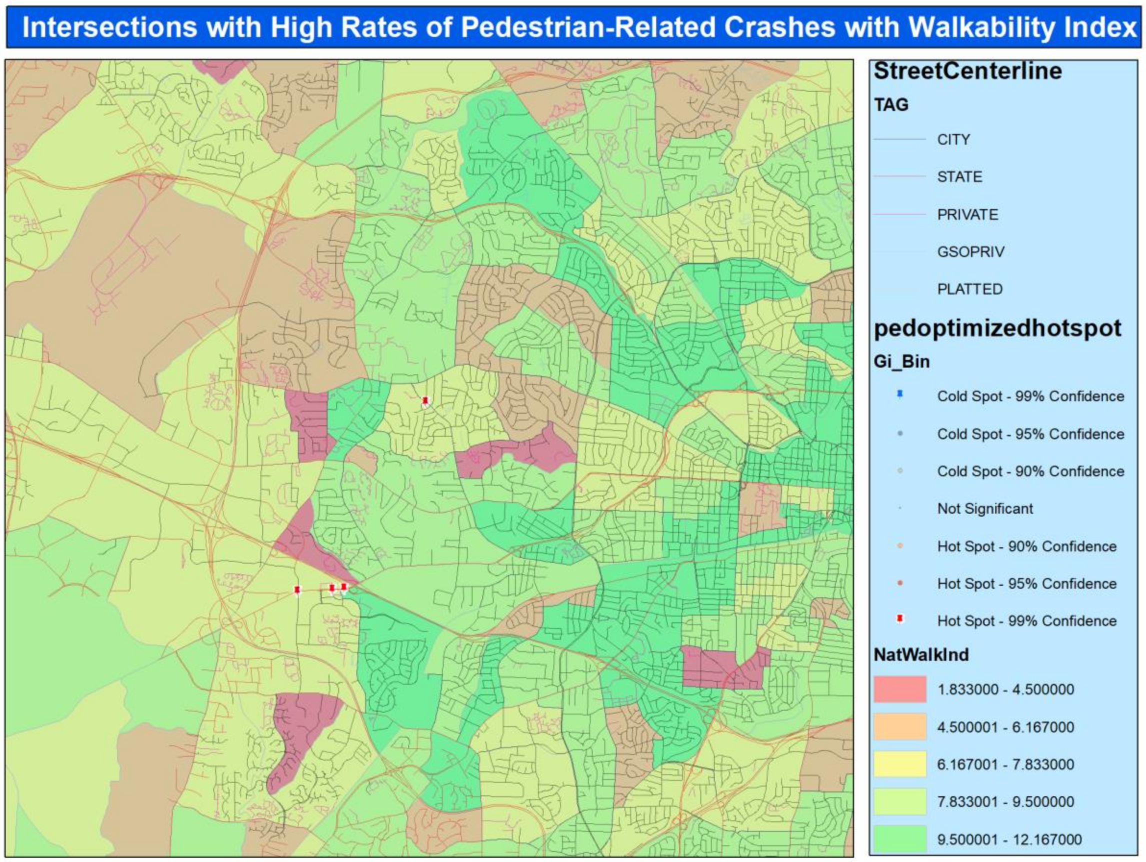
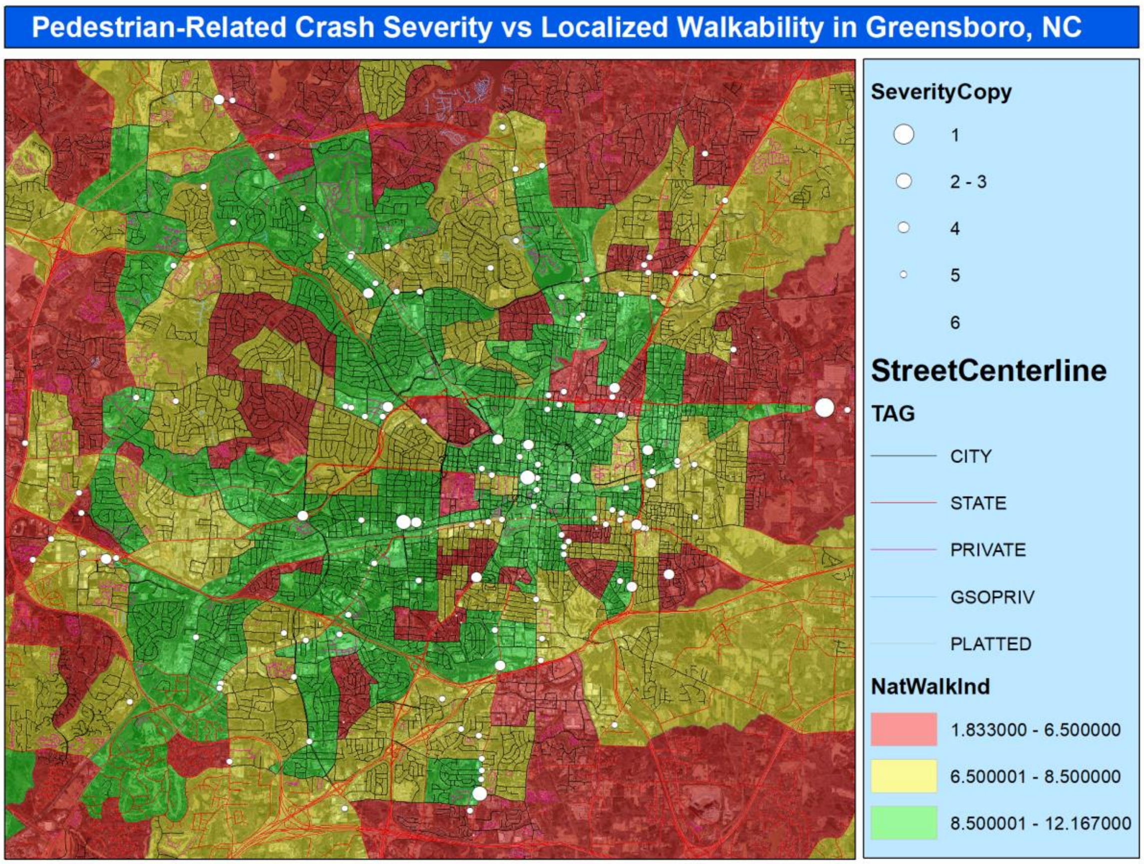


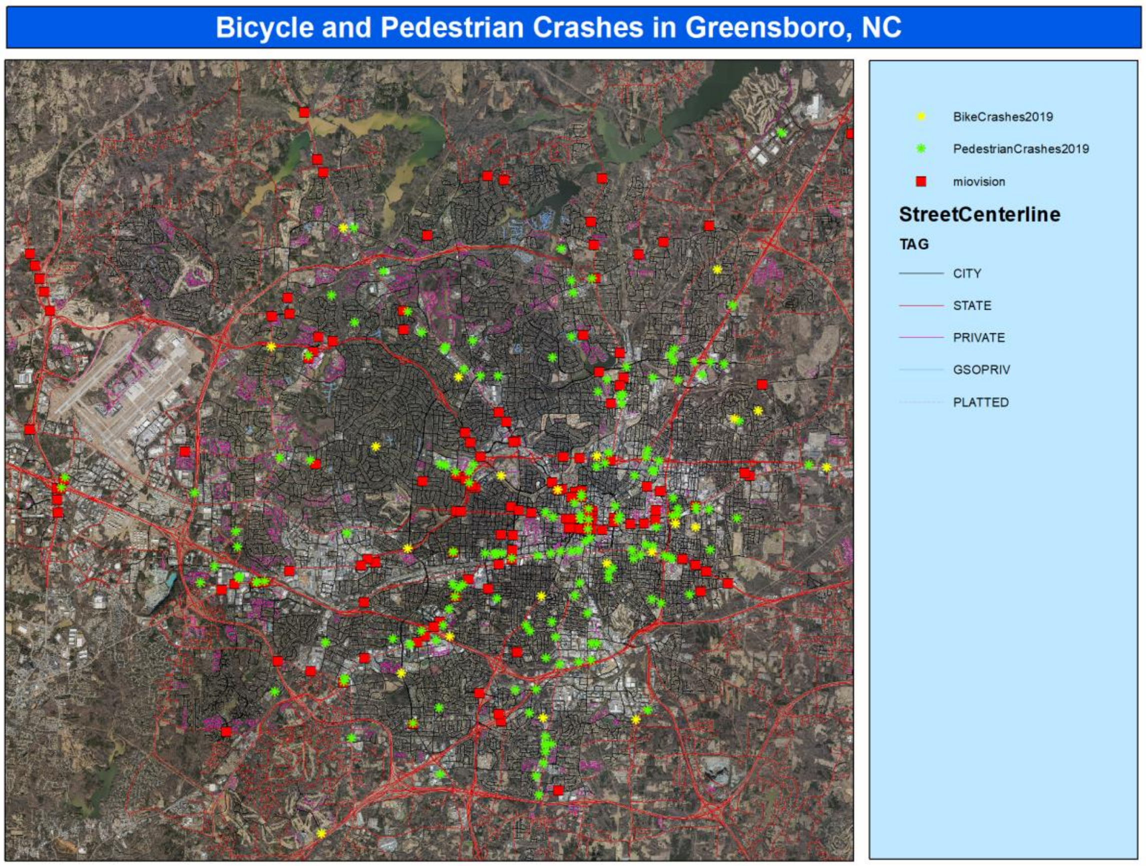
Figure 25


Intersections with High Rates of Pedestrian-Related Crashes with Walkability Index
StreetCenterline
TAG
CITY
STATE
PRIVATE
GSOPRIV
PLATTED
pedoptimizedhotspot
Gi_Bin
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not Significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence
NatWalkInd
1.833000 - 4.500000
4.500001 - 6.167000
6.167001 - 7.833000
7.833001 - 9.500000
9.500001 - 12.167000

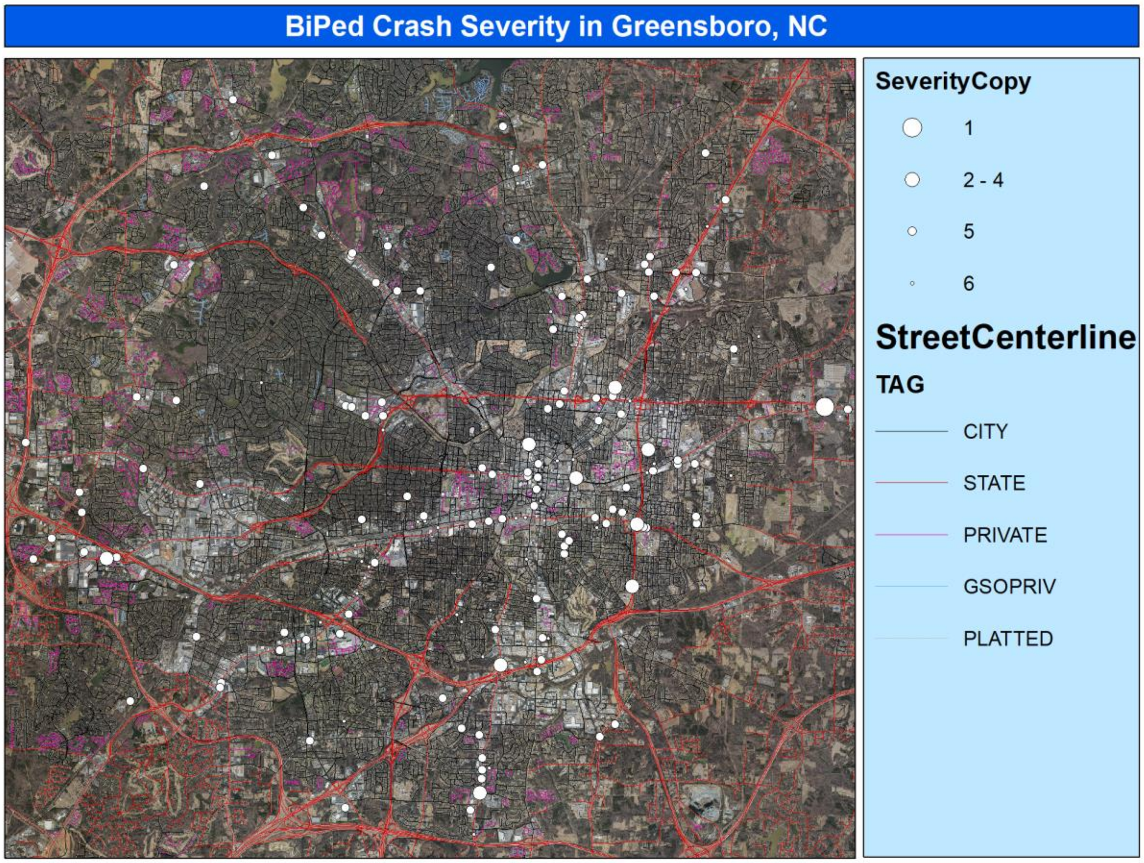
(Figure 26)


Pedestrian-Related Crash Severity vs Localized Walkability in Greensboro, NC
SeverityCopy
1
2 - 3
4
5
6
StreetCenterline
TAG
CITY
STATE
PRIVATE
GSOPRIV
PLATTED
NatWalkInd
1.833000 - 6.500000
6.500001 - 8.500000
8.500001 - 12.167000

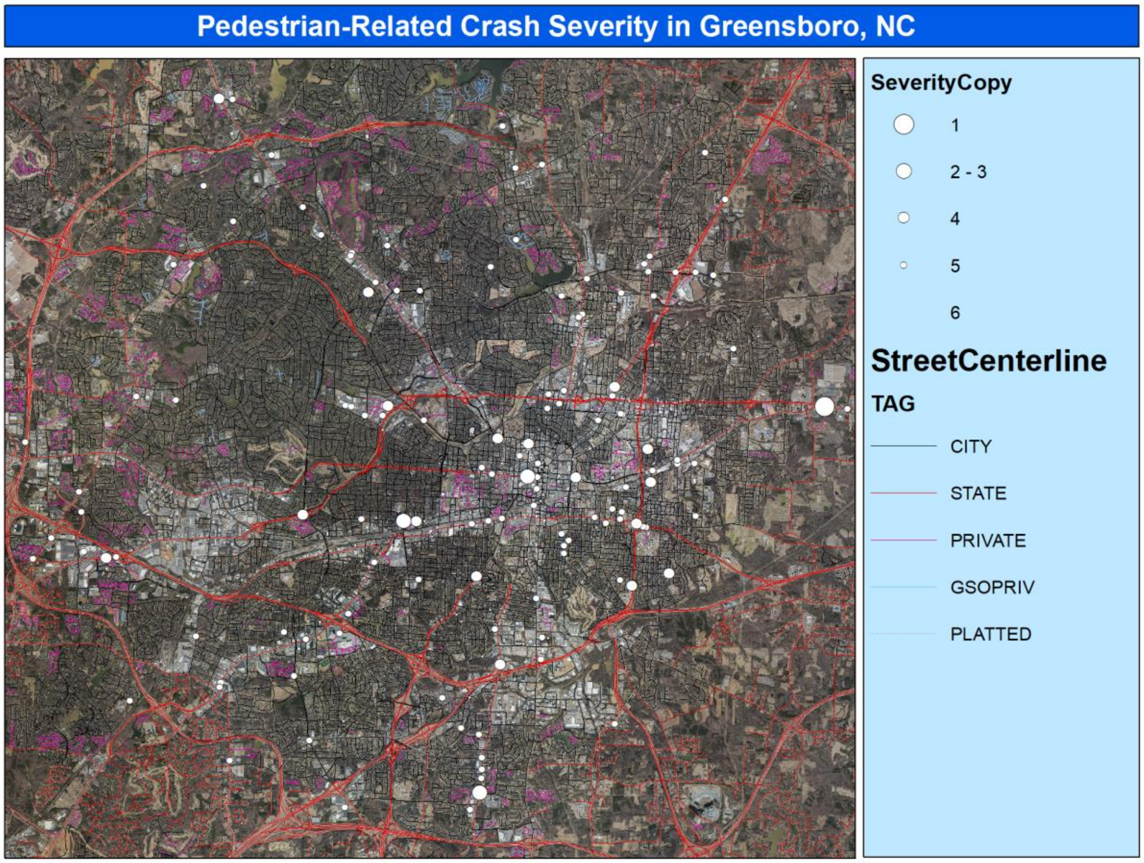
(Figure 27)


Bicycle and Pedestrian Crashes in Greensboro, NC
BikeCrashes2019
PedestrianCrashes2019
miovision
StreetCenterline
TAG
CITY
STATE
PRIVATE
GSOPRIV
PLATTED

(Figure 28)


BiPed Crash Severity in Greensboro, NC
SeverityCopy
1
2 - 4
5
6
StreetCenterline
TAG
CITY
STATE
PRIVATE
GSOPRIV
PLATTED

(Figure 29)



(Figure 30)

Section 4.6: Bicycle-Related Crash Patterns

Finally, due to insufficient bicycle crash data to perform a normalization, I did a kernel density of all bicycle-related crashes to analyze hotspots. Figure 31 shows the distribution of the crashes with severity values, Figure 32 focuses on areas of high density, and Figure 33 shows the severity patterns of these crashes. The areas of highest severity for bicycle-related crashes are in nine separate intersections. They are located at;

- the intersection of W Meadowview Rd/Emerald Rd,
- the road segment on Freeman Mill Rd between W Florida St and Barringer St,
- the S Holden Rd intersection with the W Wendover/Holden Rd exits,
- the southern intersection of Fleming Rd/Joseph M Bryan Blvd on and off ramps,
- the intersection of Horse Pen Creek Rd/Battleground Ave,
- the intersection of Robin Hood Dr/David Caldwell Dr.,
- the intersection of Hillside Dr/W Smith St/Benjamin Parkway,
- The intersection of Gillespie St/Hillsboro St.

All of these bicycle-related crash hotspots, except for the Gillespie/Hillsboro intersection, are higher-speed, multi-lane roads. Two of these intersections take place right off major roads that have high speeds and high traffic volumes.

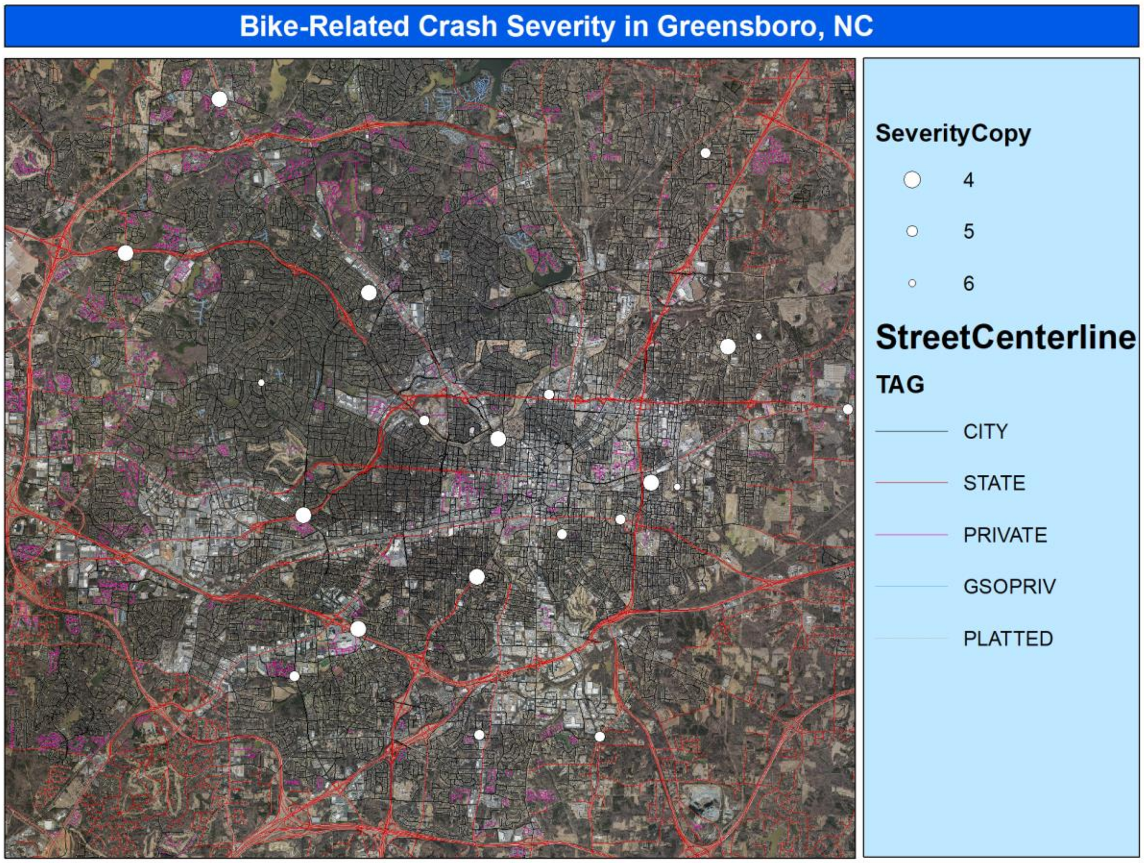
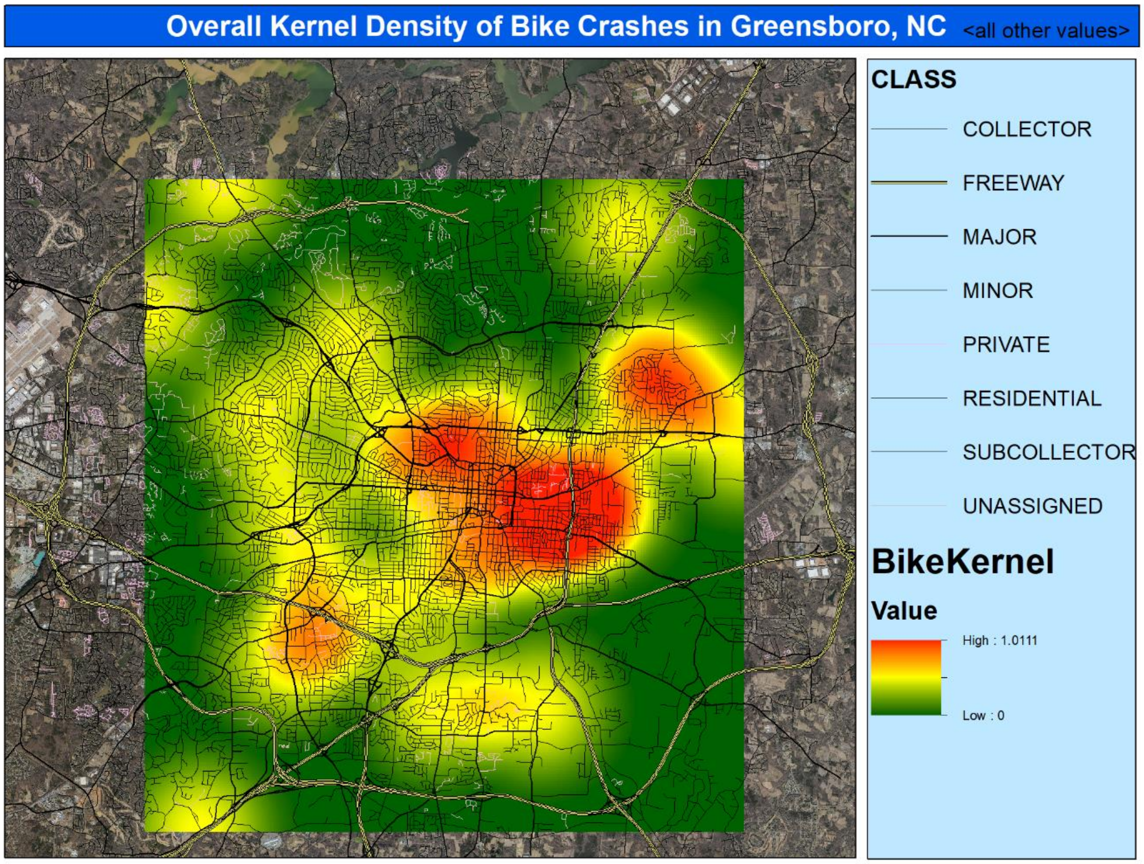

Bike-Related Crash Severity in Greensboro, NC
SeverityCopy
4
5
6
StreetCenterline
TAG
CITY
STATE
PRIVATE
GSOPRIV
PLATTED

Figure 31



Overall Kernel Density of Bike Crashes in Greensboro, NC
<all other values>
CLASS
COLLECTOR
FREEWAY
MAJOR
MINOR
PRIVATE
RESIDENTIAL
SUBCOLLECTOR
UNASSIGNED
BikeKernel
Value
High : 1.0111
Low : 0

Figure 32

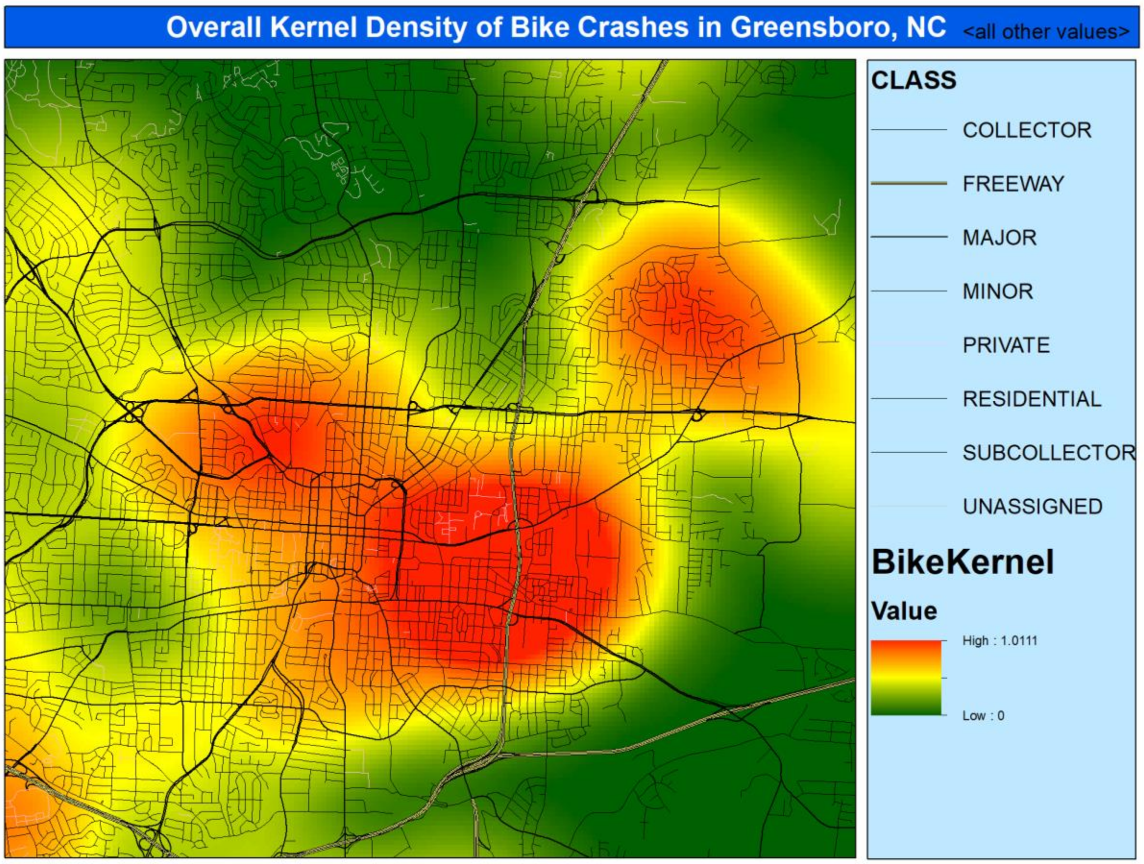


Figure 33

In summary, hotspot analysis and kernel density analyses were used to study the patterns of crash data through all injury classes and travel modes. There needs to be more variables and indices done to more accurately determine the conditions for high severity crashes. Based on the analyses done, speed and the number of lanes are common factors for areas of high volumes of crashes.

CHAPTER V: CONCLUSIONS

In conclusion, there is still a lot to do to reduce traffic crashes in Greensboro. One major project, the Greensboro Urban Loop, is scheduled to be completed by the end of the 2021 year. This loop may cause a paradox where traffic will be reduced on Wendover and I-40 but will also increase car usage in the county because of new car-oriented development at each exit. The BiPed-focused planning is good but can go further. There are many miles of bike lanes being constructed but very few protected bike lanes with cement medians or walls separating bicyclists from the cars speeding by. A recent bike lane that is particularly exciting for me has been the new one on Spring Garden Rd near UNCG. This one has cones separating bicyclists and motorists which is a much needed improvement over the common painted lanes.

I would like more accessibility in the transit options and also more focus on low-carbon travel modes. Making more of the city outside the downtown area easier to travel by walking or biking would greatly reduce car crashes and serious injuries. Adjusting the auto centric-planning to a safer, BiPed land use is a must.

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